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A STUDY OF THE LONG BONES OF THE ENGLISH SKELETON

BY
KARL PEARSON, F.R.S. AND JULIA BELL, M.A.

TEXT

PART I, SECTION II. THE FEMUR OF MAN WITH SPECIAL REFERENCE TO OTHER PRIMATE FEMORA

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CHAPTER VII

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PART I. DISCUSSION OF SPECIAL FEMORAL CHARACTERS IN MAN.

A. GENERAL CHARACTERS.

I (*a*). *The Fundamental Lengths of the Femur.*

The desirability of measuring at least one fundamental length on the femur has been universally recognised, but unfortunately the chief authorities differ widely in their selection of a fundamental length and as few take all the major lengths the want of a standard length sadly impedes comparative study. The chief lengths on which stress has been laid are:

- (*a*) The Maximum Length (see p. 4, (*a*)).
- (*b*) The Oblique Length (see p. 4, (*d*)).
- (*c*) The Trochanteric Length (see p. 4, (*b*)).
- (*d*) The Maximum Trochanteric Length (see p. 4, (*c*)).
- (*e*) The Trochanteric Oblique Length (see p. 7, (*e*)).
- (*f*) The Diaphysial Length (Bumüller).
- (*g*) Mikulicz's Length of Anatomical Axis.

The French following Broca have largely adopted the oblique length and in a French memoir when no further statement is made the femoral lengths given will almost invariably be oblique lengths. The origin of this usage is probably the idea that as a component part of stature it would be most highly correlated with stature, but as we have already indicated (p. 5) stature has been shown by one of us to be slightly more closely correlated with maximum than with oblique length[1].

Since then some writers give only the oblique length it is desirable to have formulae for passing from the oblique femoral length, f_o, to the maximum length, f_m. We have found these for our English material, but the correlation is so high that they are probably adequate in practice for other races.

The formulae are:

$$♂ \text{ R., } f_m = 1\cdot 023,24 f_o - 7\cdot 907 \pm \cdot 120;$$
$$♂ \text{ L., } f_m = 1\cdot 003,74 f_o + \cdot 553 \pm \cdot 120;$$
$$♀ \text{ R., } f_m = \cdot 994,80 f_o + 5\cdot 802 \pm \cdot 135;$$
$$♀ \text{ L., } f_m = 1\cdot 002,81 f_o + 1\cdot 908 \pm \cdot 113.$$

The probable errors are those for the determination of f_m from f_o for a single bone. If the mean of n bones be taken, the probable errors must be divided by $\sqrt{n}$. It is clear that the probable errors are well within the accuracy of measurement.

We tested these rather elaborate formulae on a considerable series of individual bones and found the estimate for a single bone came, as we might anticipate from the form of the results[1], to adding on to f_o the difference of the means of f_m and f_o for our series, *i.e.* to predict f_m from f_o add to f_o:

---

[1] Oblique Length has for both ♂ and ♀ a greater coefficient in the regression equation than Maximum Length, but the errors in stature as determined from length of femur do not depend on the size of these coefficients, but on the size of $\sqrt{1-r^2}$, where r is the coefficient of correlation.

2·4 for ♂ R., 2·2 for ♂ L., 3·7 for ♀ R., 3·0 for ♀ L.

Pearson[2] in 1898 working on Rollet's rather slender French data[3]—too slender to separate R. and L. bones (50 bodies of each sex)—gave 3·3 as the difference between female maximum and oblique length and 3·2 as the male difference. The former was in good accord, if fortuitous, the latter wants reducing by 0·9 mm. Of course there may be a racial difference in this value between French and English. Parsons[4] who does not carry his means to the decimal place needful in such a case gets for $f_m - f_o$:

Rothwell: ♂ R., 3; ♂ L., 4; ♀ R., 1; ♀ L., 4;

while Warren[5] has:

Naqada: ♂ R., 3·35; ♀ R., 4·12.

These are still higher than Parsons' ♂ and ♀ R., but agree with our results in making the difference in the female greater than in the male. The results just cited are based on slender material, but they may suffice to indicate that the values we have given must not be extended to other races without caution. Our original equations will then as a rule give a somewhat better result than the difference of means, and should therefore be used for racial investigations on the *means* of series[6].

Of course the chief uses of either maximum length or oblique length are for the reconstruction of stature, or for the membral indices. As the reconstruction formulae have been given for both maximum and oblique lengths the reduction is not essential in this case, but it is very important in the case of the membral indices, when it is needful to introduce uniformity into comparative data.

The Trochanteric Length was undoubtedly introduced to get over the effect of the variability of the collar angle on the maximum length and because it is more or less feasible to determine its value on the living. Klaatsch appears to advocate its general use as the primary femoral length, and has adopted it for the calculation of a certain number of indices, which is unfortunate as it has not been adopted for similar indices by other writers. We shall shortly discuss these indices.

We are not aware that much use has been made of either maximum or oblique trochanteric lengths, but one or other is tabulated by many femoralogists. All the trochanteric lengths are highly correlated; for example, for oblique trochanteric and direct trochanteric length the values are:

♂ R., ·996; ♂ L., ·997; ♀ R., ·994 and ♀ L., ·996.

---

[1] Take for example ♂ L.: $f_m = f_o + \cdot 00374 f_o + \cdot 553$; in the second very small term we may put the *mean* value of f_o, 445·481, at least as long as we are dealing with English femora. Its value is then 1·666, giving $f_m = f_o + 2\cdot 2$ as above. This method *cannot* be extended generally to regression equations and the adding of the difference of means will often lead to erroneous results. It depends here for its validity on the closeness of the regression coefficient to unity.

[2] Bibl. 79, p. 184. [3] Bibl. 46, p. 196. [4] Bibl. 111, p. 243. [5] Bibl. 77, p. 140.

[6] Warren's ♂ R. would have $f_m = 458\cdot 6$ as judged by the equation on our p. 226 from his $f_o = 455\cdot 95$, as against 458·3, found by adding difference of English means, and 459·3 actual.

There would be no difficulty in finding reconstruction formulae for any of these major lengths were they required. In the above case it would be adequate to add to the oblique to get the direct trochanteric length the quantities:

♂ R., 2·5; ♂ L., 2·1; ♀ R., 4·1; ♀ L., 2·6.

These show, as in the case of maximum and oblique length, the same excess of R. over L. and ♀ over ♂ in the differences of the two lengths. Further, if we club R. and L. bones together, we have:

Difference of Oblique and Maximum Lengths ... ... ♂ (R. + L.), 2·3; ♀ (R. + L.), 3·35;
Difference of Oblique Trochanteric and Direct Trochanteric Lengths ♂ (R. + L.), 2·3; ♀ (R. + L.), 3·35;

or complete identity. This suggests how little the collar angle has to do with the matter, and how closely these differences depend on the obliquity of the shaft.

The Diaphysial Length is measured from the upper end of the spiral line to the middle of the upper border of the patellar surface. It has been taken by Bumüller[1] as his primary femoral length, and he proposes to deduce the oblique length from it by an increase of 16 $^{\circ}/_{\circ}$. Reversing this process the diaphysial length would be about 367 ♂ (R. + L.) and 335 ♀ (R. + L.) for our 17th century Londoners. Actually we find 73 ♂s 378·1, 62 ♀s 347·0, or to deduce the oblique length we must use 12·6 $^{\circ}/_{\circ}$ and 12·1 $^{\circ}/_{\circ}$ respectively, not 16 $^{\circ}/_{\circ}$. Bumüller[2] gives:

346 ♂ Bavarians, Diaphysial Length 384·8; 53 ♀ Bavarians, Diaphysial Length 354·7.

These may be compared with his values[3] deduced from about 350 (R. + L.) ♂ femora for the other lengths:

	Mediaeval Bavarians ♂ (R. + L.)	17th century Londoners ♂ (R. + L.)
Maximum Length ...	450·2	447·2
Oblique Length ...	445·4	444·9
Diaphysial Length ...	384·8	378·1

We have not measured the diaphysial length on the great mass of our femora, although we have taken it on the ape and on the non-adult human femora. Our nearest length to it is the shaft length, ♂ 377·1, ♀ 347·7, and thus the diaphysial length is on the average sensibly equal to the shaft length.

Bumüller's reasons for rejecting all other primary lengths in favour of the diaphysial length are given in his Chapter II (S. 15 *et seq.*), but they seem to us far from convincing. His method of taking it with the tape is also unsatisfactory from the standpoint of stature relations, if the femur is much bowed. On the other hand, an index of robusticity or those of transverse or sagittal slenderness based on the diaphysial length, certainly permit the comparison of these characters in adult and infantile femora, and this is an advantage. Further arguments in favour of the use of the diaphysial length are: (*a*) that it can be taken on more bones than the maximum length[4], (*b*) that it has less variation than the other lengths. This may be true but is not demonstrated by the methods for measuring variation adopted by Bumüller. Thus

[1] Bibl. 81, S. 139. [2] Bibl. 81, S. 84. [3] Bibl. 81, S. 19.

[4] It is strange, however, that on S. 19 Bumüller takes the maximum length on 350 and the diaphysial length on only 346 femora.

he takes 10 mm. ranges on either side of the means and finds 34·6 °/o of his bones lie inside this range in the case of the maximum length, 32·6 °/o in the case of the oblique length and 34·1 °/o in the case of the diaphysial length. This must mean that the standard deviations of the three lengths are nearly equal, and hence that the coefficient of variation of the diaphysial length must be about 17 °/o *greater*.

Bumüller passes this result by without comment, and next proceeds to measure variation by the range from minimum to maximum value, a very fallacious proceeding. He finds the range for maximum length to be 153 mm. and for diaphysial length 121 mm. On this he remarks: "Die wahre Länge des Schaftes weist also bedeutend geringere Schwankungen auf[1]." But the remark shows that he has not only disregarded the statistical principle that range is a very poor measure of variation, but also the more obvious consideration that the sizes of the varying quantities are not the same. Even the poor test of total range shows that for maximum length the variation, 3·4 °/o of its size, is only slightly in excess of the 3·1 °/o of the size in the case of diaphysial length.

Lastly, there is in many bones considerable difficulty in determining what is the upper end of the spiral line ("vom oberen Ende der *linea obliqua*," Bumüller). In the sample femur which has been on the table while this memoir was in progress, the spiral line is a centimetre broad where it joins the rugosities of the great trochanter. Bumüller does not state which point of this broad rugose belt is to be taken as the "upper end of the spiral line." The anterior face of the bone frequently runs up into a narrow neck between spiral line and great trochanter, and this neck may contain isolated rugosities of either the spiral line or the great trochanter, so that it is not easy to state at the upper end of the spiral line where the diaphysis ends. We believe it would be best to measure the diaphysial length in the following manner:

Place the bone in the standard position on the table and mark the summit of the tubercle of the femur (proximal limit, L_p); carry a thread from this summit to the mid-trochlear point and mark, when it is taut, where it meets the patellar border (distal limit, L_d). The distance L_pL_d from proximal limit to distal limit, taken with the calipers (not the tape), shall be termed the diaphysial length. In any future system of femoral measurements we should feel inclined to take this diaphysial length, and base on it a second index of robusticity, *i.e.* 100 × the sum of the pilastric diameters divided by the diaphysial length. Possibly also it might be used for the indices of sagittal and transverse slenderness in place of the length of shaft[2]. We could not, however, follow Bumüller in treating this diaphysial length as the paramount femoral length and neglecting for it other major lengths which seem to be essential for stature estimates and for the membral indices.

---

[1] Bibl. 81, S. 19.

[2] Suppose the sagittal plane through mid-trochlear point O and coaxial point D to meet the *anterior* border of the spiral line in S. Then L_dS would be a very fair diaphysial length, perhaps 40 mm. shorter than our revised Bumüller's measurement. But the distance DS projected on the standard vertical plane is almost equal to the distance OL_d projected on the same plane, say 1·5 to 2 centimetres in both cases. Thus our shaft length apparently terminating proximally at a point not on the epiphysial border is really a much better approach to a diaphysial length than the reader might at first sight give it credit for being. The difficulty about taking L_dS directly lies in the determination of the exact point where the sagittal plane through O and D meets the *anterior* border of the spiral line. For this reason we have selected the summit of the tubercle of the femur as a more definite limit.

Another femoralogist, almost as suggestive as Bumüller and who has done valuable work, Mikulicz, is again unconventional in his choice of a paramount femoral length. As far as we are aware he has found no followers in the thirty-nine years that have elapsed since the publication of his paper[1]. Mikulicz replaced the mid-trochlear point O by an intracondylar point b, taken midway between the points in which the condyles touch the standard horizontal plane[2]. He joins this point to the summit a of the great trochanter and apparently assumes the line ab to pass through the coaxial point $m =$ our O. Further let n be the spherical centre of the head and bn meet the surface of the head in c, and mn meet the head in e. Then me corresponds to our capito-collar axis, mn to our length of neck. Mikulicz terms cb the "mechanical axis" of the femur and ab the "anatomical axis." He terms the mechanical axis the measure of the femur (*Maass für das Femur*). bm is Mikulicz's length of shaft and am his height of great trochanter. A little consideration will show that Mikulicz's length of anatomical axis must be almost the mean of our trochanteric length and of our maximum trochanteric length. We are thus able to deduce the following values for Mikulicz's measure in the case of our London bones:

Length of Anatomical Axis.

♂ R., 430·58; ♂ L., 429·83; ♀ R., 393·63; ♀ L., 393·24.

The mean total length of femur + tibia for Mikulicz's material appears from the data on his S. 365—6 to have been 793·2 mm. He further tells us (S. 254) that the proportion of the femur was in the mean 56·4 to 100 of the combined tibio-femoral length. Hence his mean mechanical axis was 447·36 mm. But he further gives on S. 370 a table of the angle between his mechanical axis and his "knee-basis." The mean value of the angle there recorded is 86° 39′. Accordingly the oblique length of his femora which should be the perpendicular from the top of his mechanical axis on his knee-basis $= 447·36 \times \sin 86° 39' = 446·60$. Now his material consisted of bones from the bodies sent to the dissecting rooms of three Viennese hospitals, and he particularly says that he does not know anything about the sexes and has not endeavoured to separate them. The above value of the oblique length would correspond well with Bumüller's Bavarians (see our p. 228), if it consisted only of male bones. But if it consisted of the two sexes in fairly even numbers the mean[3] length of the male femur must have been about 467 mm., which is a very high value for the mean oblique length of a male femur. We should be surprised to find a value above 460 at most for such a hospital population. Hence it seems probable that Mikulicz either selected the better or larger 100 of his 200 bones to work with, or that the bulk of the bodies were male. In which case his data would agree well with Bumüller's result. Still his material seems to have been tall. For, remembering that his anatomical axis is 447·36 and that the maximum trochanteric length exceeds the trochanteric length by about 8·7 mm., we can reverse the process by which we have reached the anatomical axis of our Londoners, and we find the maximum trochanteric length of Mikulicz's Viennese to be 451·7. Again the maximum length exceeds the trochanteric by about 12·0 mm., so that Mikulicz's population would have a maximum length of about 464, considerably in excess of our Londoners or indeed of Parsons' Rothwell femora. The same point is illustrated by comparing his length of shaft = 48·7 × 793·2,—*i.e.* Mikulicz's proportion (S. 363) of shaft × by his tibio-femoral length,— = 386·3, which less 1·5 cm. for distance from his intracondylar point to our mid-trochlear point gives 371 for his measurement of what we term the shaft length, and has to be compared (supposing a moiety of each sex) with 362 for our Londoners. Finally we can obtain from Mikulicz's data the length of neck, vertical diameter of head and pilastric transverse; they give the following results, always assuming the sexes equally distributed:

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[1] Bibl. 22, S. 351 *et seq.*

[2] Mikulicz does not closely describe how b is to be determined. He uses a lamp-blacked standard horizontal plane to mark the points of contact of his condyles, and he terms the distance between these blackened points the "knee-basis"—"auf welcher man sich Femur und Tibia in Berührung zu denken hat," *loc. cit.* S. 354.

[3] The female femur would be about 8·8 °/₀ less than the male in oblique length: see our p. 145.

	17th century Londoners	19th century Viennese
Length of Neck ...	50·5	54·7
Diameter of Head ...	43·9	48·4
Pilastric Transverse	26·6	28·6

The differences are so considerable on this hypothesis that although we must admit the Viennese to be the bigger, we are still compelled to hold that the bulk of Mikulicz's material must have been male[1].

While Mikulicz's mechanical axis is possibly of importance for a study of the tibio-femoral relations, it is a great drawback that he has given no absolute means, but only proportions, carried to *one* decimal per cent., of other characters in terms of his tibio-femoral length. Further his disregard of sex and side still further reduces the value of his data for comparative purposes. Lastly his individual "measurement of the femur" renders his tibio-femoral index of less value than it would otherwise be for interracial studies, wherein as a rule more customary lengths have been taken as the basis of the ratio.

Trochanteric Lengths. While quite a number of writers have recorded one or other trochanteric length, few, notwithstanding a good deal of advocacy of its advantages[2], have turned the recorded values to any real use. Among these few Klaatsch must be particularised. He has adopted the trochanteric length as the basis of three indices. These indices are:

(*a*) 100 × Breadth of Proximal Epiphysis / Trochanteric Length. This we initially rejected on the ground that the distance from the great trochanter to the mesial face of the head was not a satisfactory measurement, being largely dependent on the cervical angle and compounded of parts anatomically differentiated. Later we determined it for 135 femora.

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[1] Our capito-trochlear length is 432 for males (R. + L.) and 394 for females (R. + L.). Adding 15 mm. for distance from mid-trochlear point to intracondylar point of Mikulicz we reach ♂ 447, ♀ 409 for Mikulicz's "mechanical axis" in our London femora. The former is identical with Mikulicz's value, but the combined sex value 428 is so far below his value as to confirm the view that his material was largely male.

[2] For example, that it frees the fundamental length from variations in the neck and head, that it is more of an anatomical unity than the maximum length, that it is more accessible in the living, etc.

(*b*) 100 × Breadth of Distal Epiphysis / Trochanteric Length, and

(*c*) 100 × Length of External Condyle / Trochanteric Length.

(*b*) and (*c*) we have recorded. We propose in this section to compare our values for (*a*) and (*b*) with such material as we have been able to put together from other sources. Klaatsch gives unfortunately scarcely more than individual values[1] for (*a*) and (*b*) and uses the inverse of the ratio multiplied by ten, *i.e.* although he says: "druckt man die Proportion der distalen Breite zur Trochanteren Länge zahlenmässig aus," he actually divides the trochanteric length by the bicondylar width and repeats this process with the length of the external condyle for (*c*). The table on the following page has been obtained from a few of our own measurements, but principally from those of Klaatsch and Prochownick[2]. The latter gives only the proximal breadth and the maximum not the trochanteric length. If we call the index the *Proximal Breadth Ratio*, we have, based upon a slight modification of our ratio of maximum to trochanteric length in Londoners[3]:

Proximal Breadth Ratio (for trochanteric length) = 1·04 × Proximal Breadth Ratio (for maximum length), or inverted Proximal Breadth Ratio (for maximum length) = ·962 × Proximal Breadth Ratio (for trochanteric length).

Several important points flow from the table on p. 233:

(*a*) There is nothing as far as it extends to indicate any advantage in using trochanteric instead of maximum length in forming the index. Where we can get an index in both ways the calculated value is for all practical purposes as good as the observed[4].

(*b*) The only racial differentiations to be noted here are (i) the separation of *Homo primogenius* and (ii) probably the Australians from modern civilised and modern primitive man.

(*c*) As in several other cases we have dealt with, *Homo primogenius* and the Australians are on *opposite* sides of modern civilised man and of most of the modern primitive races. Whatever may be claimed for the skull the Australians are not for the femur closer to *Homo primogenius* than to modern civilised man.

(*d*) As in many other features there is nothing to distinguish the Trinil femur from that of modern man.

(*e*) This index, at any rate for the small numbers provided by Klaatsch[5], seems quite incapable of differentiating the bulk of human races. If it is of any value at all its value could only be ascertained after it had been applied to far longer series. The range of Klaatsch's Badenser or of Prochownick's Viti Islanders covers individually nearly the whole of the racial means provided except *Homo primogenius* and the Australians.

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[1] Bibl. 87, SS. 651—3, 657.

[2] Bibl. 43, Table I.

[3] We should not expect very close results if these formulae be applied to the apes.

[4] It may be asserted that the trochanteric length can be more often taken than the maximum length. This is contrary to our experience given in Table I, p. 115. The great trochanter is on the whole more likely to be damaged than the head in disinterred adults. When the head is damaged the maximum length can then be fairly accurately reconstructed from the trochanteric length.

[5] It is difficult to understand what Klaatsch proposed to deduce from his tables of this index. He gives the individual indices of *five* Badenser, many other Europeans were at his command. He picks out *five* Viti Islanders out of Prochownick's 31, *five* Australians out of Prochownick's 8 (he does not confine himself to one sex, and he has misread oblique length for maximum length in at least one case) and *three* Caroline Islanders out of Prochownick's 12. He gives no reasons for these selections, nor the means of his individual cases. Almost any conclusions could be drawn by such selection, and when drawn would be wholly illegitimate. Yet this is by no means a unique illustration of anthropometric work in Germany in the twentieth century!

In conclusion we do not believe that this index is anatomically of any special importance. It is largely dependent on the individual rugosity development of the great trochanter, and the proximal breadth is a very heterogeneous quantity and difficult to measure accurately.

TABLE I. *Proximal Breadth Ratio**.

Race and No.	On Trochanteric Length		On Maximum Length	
	Found	Calculated from M. L.	Found	Calculated from T. L.
Gorilla (7)	27·06	27·92	26·85	26·03
Chimpanzee (2)	22·15	22·65	21·78	21·31
Orang-utan (5)	27·50	26·50	25·48	26·46
Gibbon (3)	15·10	15·44	14·85	14·53
Dryopithecus rhenanus (Eppelsheim)	17·60	—	17·42	16·93
Pithecanthropus erectus (1) ...	21·46	21·49	20·66	20·64
Neanderthal (2)	24·88	24·96	24·00	23·93
Spy (2)	26·83	26·60	25·58	25·81
Homo mousteriensis (*Hauseri*) (1) ...	24·79	24·76	23·81	23·85
Galley Hill (1)	—	24·55?	23·61?	—
Javanese (1) Kl.	23·50	—	—	22·60
Japanese (1) Kl.	22·31	—	—	21·46
Veddah (1) Kl.	22·12	—	—	21·28
American Indians (2) Kl.	22·11	—	—	21·27
17th century Londoners (135) ...	22·09	21·84	21·00	21·25
Malay (1) Kl.	21·71	—	—	20·89
Gilbert Islanders (3) Kl. & Pr. ...	—	21·44	20·42	—
Badenser (5) Kl.	21·36	—	—	20·55
Fuegians (Ona and Yaghan) (8) H.	21·24	21·25	20·43	20·43
Viti Islanders (31) Pr.	—	20·81	19·82	—
Negrito (1) Kl.	20·51	—	—	19·73
Caroline Islanders (12) Pr. ...	—	20·59	19·80	—
Hindoos (3)† Kl.	18·23	—	—	17·54
Australians (8) Pr.	—	18·21	17·34	—

* Allowance has to be made for the standard lengths used by various writers. Contractions as in following table.

† Quite unreliable, two out of three femora are from one skeleton with a very low index value.

We now turn to the Distal Breadth Ratio and treat it in like manner.

Now this table for the Distal Breadth Ratio suffices to indicate that exactly as in the case of the Proximal Breadth Ratio there is no advantage in using the trochanteric instead of the maximum length. The index as calculated from one or the other suffices to obtain the corresponding value with all requisite accuracy.

In regard to modern man, wild or civilised, both here and in the previous index larger series would be required to emphasise the nature of the interracial differences,

TABLE II. *Distal Breadth Ratio**.

Race and No.	On Trochanteric Length		On Maximum Length	
	Found	Calculated	Found	Calculated
Gorilla (7)	24·63	25·57	24·59	23·69
Chimpanzee (2)	22·25	22·91	22·03	21·40
Orang-utan (5)	22·90	22·06	21·21	22·03
Gibbon (3)	13·15	13·57	13·05	12·65
Dryopithecus rhenanus (Eppelsheim)	14·50	14·89	14·32	13·95
Pithecanthropus erectus (1)... ...	17·39	17·37	16·70	16·73
Neanderthal (2)	20·52	20·65	19·86	19·74
Spy (1)	21·95	22·29	21·43	21·12
Homo mousteriensis (*Hauseri*) (1)	22·49	22·56	21·69	21·64
Galley Hill (1)	—	21·58	20·75?	—
Japanese (20) Kog....	20·56	20·20	19·42	19·78
Javanese (1) Kl.	20·50	—	—	19·72
Aino (36) Kog.	20·13	20·05	19·28	19·37
Gilbert Islanders (3) Kl. & Pr. ...	19·76	—	—	19·01
Anau, North Kurgan (2) Mol. ...	19·45	19·02	18·34	18·71
Fuegians (15) Mar. & H.	19·36	19·45	18·70	18·62
Maori (10) Mol.	19·17	19·05	18·32	18·44
,, (21) Mol. & Hep.	—	18·72	18·00	—
American Indians (2) Kl.	19·06	—	—	18·34
Laplanders (4) Hep.	—	18·90	18·17	—
17th century Londoners ♂ R. (135)	18·82	18·84	(152) 17·94	17·92
17th century Londoners ♂ L. (148)	18·72	18·63	(161) 17·74	17·82
17th century Londoners ♀ R. (93)	18·22	18·18	(99) 17·31	17·35
17th century Londoners ♀ L. (104)	18·05	18·05	(112) 17·19	17·18
Modern British (36) Hep.	—	18·78	18·06	—
Swiss Alemanns ♂ (c. 88) Sch. ...	—	18·63	17·91	—
,, ,, ♀ (c. 88)	—	18·21	17·51	—
Modern Swiss (21) Sch.	—	18·58	17·87	—
Malay (1) Kl.	18·54	—	—	17·83
Caroline Islanders (12) Pr. ...	—	18·50	17·79	—
Sandwich Islanders ♀ (4) Hep. ...	—	18·44	17·73	—
Eskimos (4) Hep.	—	18·40	17·69	—
Veddah (1) Kl.	18·35	—	—	17·65
Andamans (11) Hep.	—	18·26	17·56	—
Viti Islanders (31) Pr.	—	18·09	17·40	—
Modern Badenser (8) Kl.	18·06	—	—	17·37
Negrito (1) Kl.	17·95	—	—	17·27
Bajuvars, Swabians and Alemanns from Row Graves (c. 16) L.-N.	17·52	17·66	16·98	16·85
Hindoos (8) Kl. & Hep.	—	17·44	16·77	—
Negroes (9) Hep.	—	17·42	16·75	—
Australians (22) Hep. & Pr. ...	—	17·15	16·49	—

* Material has been drawn from a considerable number of authorities, whose names are indicated at the side (Kl. = Klaatsch, H. = Hultkrantz, Hep. = Hepburn, Mol. = Mollison, Kog. = Koganei, L.-N. = Lehmann-Nitsche, Pr. = Prochownick, Sch. = Schwerz, Mar. = Martin); we have had to correct in many cases for the standard lengths used by these writers. Neither the Proximal nor Distal Breadth Ratio is tabled directly by any of them, and we are responsible for the calculation of the indices and determinations of the mean values.

although it is clear that modern Europeans occupy an intermediate position between Asiatics and Negroes and Australians. The primitive Australians are again separated by modern Europeans from both *Homo primogenius* and the apes. The Trinil femur fits in best with modern man, and is markedly removed from those of Primogenial man and the anthropoids. This again raises a suspicion that the Trinil femur and the skull of *Pithecanthropus erectus* were not parts of the same individual.

I (*b*). *Statures from Femoral Lengths.*

As we have already indicated (p. 5) one of the chief interests of the major femoral lengths is the reconstruction of stature. In the present instance we have used the oblique femoral length to obtain an appreciation of racial stature, because so many authorities, especially the French, only furnish this major length[1]. In a great number of cases the data are extremely sparse, the locus of origin of the femora is not stated or only inadequately stated, *e.g.* "Negroes," "Hindoos," "Chinese," "Turks." Thus some of the figures given are distinctly unreliable and their race is ill-defined. We have had in a considerable number of cases to pool material from a variety of sources and to reduce the measurements recorded to oblique length. In other cases the recorder merely states the total number of male and female bones in his series, but fails to give the exact number of either male or female bones on which his mean oblique femoral lengths are based, these alone and no individual measurements being provided. We can therefore suggest no relative weight to be given to the values provided in the table which follows[2]. Still the table may be of interest till something more accurate is forthcoming. It is based on data for the femoral length given by numerous authors, in particular Rodriguez, Hepburn, Lehmann-Nitsche, Schwerz, Bumüller, Martin, Parsons, Koganei, Scott and others, as well as our own measurements. We have added the estimates of stature determined by Pearson in his memoir of 1898 (*Phil. Trans.* 192 A, pp. 242, 3) from four long bones, and the values he gives for various races as determined by anthropometers on the living. Where the letter F_o is placed after the stature it means that the value has been determined from the oblique length of the femur only. Where no such letter appears the humerus, tibia and radius have also where available contributed to the determination of stature. If as we hold femoral reconstructions of stature are more reliable than the measurements of travellers, who may only select or be introduced to the bigger and finer natives, it would seem that a good many of the estimates provided by early travellers require modification.

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[1] For the requisite reconstruction formula, see our p. 5 above.

[2] One author will state that his material embraces 600 femora, but internal evidence may show that he considers it adequate to take his means on thirty individuals and publish no individual measurements. Another will state that he is dealing with 240 neolithic femora; possibly this number was available in large part for the pilastric index, but one may gravely doubt whether the measurement of the oblique length was possible in a quarter of this number. Serious responsibility rests with those authorities who publish merely means and not individual measurements, and still more on those who do not state the total number on which each mean is based. We have had to reject the results of several memoirs where this state of affairs is predominant, because we could only suspect from indirect evidence that the means were based on too slender numbers to be racially characteristic, or were vitiated by arithmetical blunders which could not be tested.

TABLE III. *Racial Statures.*

Index No.	Race	Authority for Data	Reconstruction from Long Bones ♂	Reconstruction from Long Bones ♀	Measurements on the Living ♂	Measurements on the Living ♀	Sex Ratio ♂/♀	Remarks
1	12 Giants (> 200)	Pearson	217·6	—	—	—	—	—
2	4 Sub-giants (Bavarian Recruits)	Ranke	—	—	190·5	—	—	—
3	3 Sub-giants (Museum Specimens)	Pearson	186·9	—	—	—	—	—
4	Samoans	Topinard	—	—	188·3	—	—	—
5	Patagonians	Moveno & Lister	—	—	185·0	—	—	See No. 36
6	Caribeans	Humboldt	—	—	184·0	—	—	See No. 105
6 *a*	Cromagnon	Rodriguez	175·7	—	—	—	—	From 13 femora: see No. 29
7	Red Indians	Topinard	—	—	175—180	—	—	See No. 36
8	Polynesians	Topinard	—	—	170—180	—	—	See No. 55
9	Flamborough Head English	Pitt-Rivers	—	—	175·2	162·5	1·078	—
10	Livonians	Topinard	—	—	173·6	—	—	—
11	Americans (born)	Gould	—	—	173·5	—	—	—
12	Fellahs (Egypt)	Wolney	—	—	173·0	—	—	—
13	English (Middle Class)	Pearson	—	—	172·8	159·9	1·080	See Nos. 25, 47, 68
14	Todas of Nilgherry	Marshall	—	—	172·7	—	—	—
15	Norwegians	Hunt	—	—	172·0	—	—	See No. 19
16	American Scottish	Gould	—	—	171·6	—	—	—
17	Bantu	Fritsch	—	—	171·8	—	—	—
18	Finns	Bonsdorff	—	—	171·4	—	—	—
19	American Norse	Baxter	—	—	171·3	—	—	See No. 15
20	Round Barrow British	Pearson	171·1	160·2	—	—	1·090	—
21	Anglo-Saxons	Pearson	170·9	156·0	—	—	1·096	—
22	American Irish	Gould	—	—	170·5	—	—	—
23	Lithuanians	Topinard	—	—	170·4	—	—	—
24	American English	Gould	—	—	170·1	—	—	See Nos. 13, 25
25	English Commonality	Galton	—	—	170·0	158·3	1·074	See Nos. 13, 24
26	Sikhs	Topinard	—	—	170·0	—	—	—
27	Bajuvars from Row Graves	Lehmann-Nitsche	169·2	154·5	—	—	1·095	♂ 169·9 (F_o), ♀ 155·4 (F_o)
28	Australians	Hepburn	169·7 (F_o)	152·6 (F_o)	—	—	1·112	—
29	Cromagnon	Pearson	169·6 (F_o)	—	—	—	—	Estimate of F_o from diaphysial caste length: see No. 6*a*
30	American Germans	Baxter	—	—	169·5	—	—	See Nos. 41, 59, 60, 62
31	Swabians and Alemanns from Row Graves	Lehmann-Nitsche	169·2 (F_o)	152·3 (F_o)	—	—	1·111	See Nos. 35, 59
32	American Danes	Baxter	—	—	169·2	—	—	See Nos. 15, 19
33	American Swedes	Gould	—	—	169·2	—	—	See Nos. 15, 19
34	Nubians	Topinard	—	—	169·0	—	—	See Nos. 12, 43
35	Swiss Alemanns	Schwerz	—	—	168·8	154·7	1·091	See Nos. 31, 62
36	Patagonians	Rodriguez	168·8 (F_o)	153·9 (F_o)	—	—	1·097	See No. 5
37	Bechuanas	Fritsch	—	—	168·4	—	—	—
38	Ancient Gauls	Rodriguez	168·0 (F_o)	154·0 (F_o)	—	—	1·091	See No. 75
39	American Negroes (pure)	Gould	—	—	168·0	—	—	See Nos. 17, 43
40	4th to 9th century Mediaeval French	Rahon & Pearson	168·0	154·8	—	—	1·085	See Nos. 52, 54, 56, 61
41	Modern German (locus ?)	Rodriguez	167·8 (F_o)	?	—	—	—	See Nos. 30, 59, 62
42	Modern British	Hepburn	167·7 (F_o)	—	—	—	—	See Nos. 24, 47,
43	Negroes (locus ?)	Rodriguez	167·5 (F_o)	153·4	—	—	1·092	See Nos. 17, 39
44	Naqadas (Prehistoric Egyptians)	Warren	167·5	156·0	—	—	1·074	See Nos. 12, 34
45	Neolithic Man in Britain	Pearson	167·3	—	—	—	—	See Nos. 74, 75 *bis*, 85, etc.

Index No.	Race	Authority for Data	Reconstruction from Long Bones		Measurements on the Living		Sex Ratio ♂/♀	Remarks
			♂	♀	♂	♀		
46	Kabyles	Prengrüber	—	—	167·3	—	—	—
47	Rothwell Mediaeval English	Parsons	167·0 (F_o)	152·2 (F_o)	—	—	1·097	Sex-ratio large for modern man
48	*Pithecanthropus erectus*	Pearson	166·8 (F_o)	—	—	—	—	From photographs
49	Guanches I	Pearson	166·8	154·7	—	—	1·078	See Nos. 57, 63
50	Romano-British	Pearson	166·7	152·2	—	—	1·090	See No. 65
51	Franks	Pearson	166·4	152·1	—	—	1·091	See No. 56
52	Modern French (I)	Rodriguez	166·3 (F_o)	158·3 (F_o)	—	—	1·051	See No. 71
53	Modern French (taken on corpse)	Rollet	—	—	166·26	154·02	1·079	See Nos. 52, 71
54	10th to 11th century Mediaeval French	Pearson	166·24	154·49	—	—	1·077	See Nos. 52, 56
55	Polynesians	Rodriguez	166·2 (F_o)	154·5 (F_o)	—	—	1·076	See No. 8
56	Franks and Merovingians	Rodriguez	166·2 (F_o)	154·0 (F_o)	—	—	1·079	See Nos. 51, 52, 53
57	Guanches II	Pearson	166·2	153·8	—	—	1·081	See Nos. 49, 63
57 *bis*	Caverne de l'Homme Mort	Rahon	166·1 (F_o)	152·8 (F_o)	—	—	1·087	—
58	Moldevins	Topinard	—	—	166·0	—	—	—
59	Bavarians (Munich district)	Ranke	—	—	166·0	—	—	See Nos. 60, 62
60	Bavarians (taken on corpse)	Bischoff	—	—	165·9	153·9	1·078	See Nos. 59, 62
61	Mediaeval French	Rodriguez	165·8 (F_o)	153·6 (F_o)	—	—	1·079	See Nos. 52, 53, 71
62	Bavarians	Bumüller	165·7 (F_o)	—	—	—	—	See Nos. 59, 60
62 *bis*	Portuguese	Tamagnini	165·6 (F_o)	150·8 (F_o)	1·645	—	1·098	—
63	Guanches III	Rodriguez	165·6 (F_o)	155·0 (F_o)	—	—	1·068	See Nos. 49, 57
64	Great Russians	Topinard	—	—	165·5	—	—	See No. 77
65	Romano-British	Hepburn	165·5 (F_o)	—	—	—	—	See Nos. 50, 75
66	Algeria, Dolmen People	Pearson	165·5	152·6	—	—	1·085	See Nos. 72 *bis*, 81
67	Melanesians	Rodriguez	165·5	153·4	—	—	1·079	See Nos. 43, 55
68	17th century Londoners	Pearson & Bell	165·4 (F_o)	152·2 (F_o)	—	—	1·087	See Nos. 13, 25, 47
69	India, Dolmen People	Pearson	165·24	154·86	—	—	1·067	See Nos. 66, 72 *bis*, 81
70	Canary Islanders	Rodriguez	165·2 (F_o)	152·4 (F_o)	—	—	1·084	See Nos. 49, 57
71	French Conscripts	Manouvrier	—	—	165·0	—	—	See Nos. 52, 53
72	Italians of Tuscany	Topinard	—	—	165·0	—	—	See Nos. 95, 100
72 *bis*	Dolmens in France	Manouvrier, Rahon	165·0 (F_o)	147·1 (F_o)	—	—	1·121 (!)	See Nos. 66, 81
73	Veddahs	Rodriguez	165·0 (F_o)	—	—	—	—	See No. 117
74	Neolithic Europeans	Rodriguez	164·9 (F_o)	152·2 (F_o)	—	—	1·083	See Nos. 45, 75 *bis*, 85, etc.
74 *bis*	Modern French	Rahon	164·8 (F_o)	150·2 (F_o)	—	—	1·097	See Nos. 52, 53
75	Romano-Gauls	Pearson	164·8	152·3	—	—	1·082	See Nos. 38, 65
75 *bis*	Neolithics, Châlons-sur-Marne	Manouvrier	164·8 (F_o)	152·2 (F_o)	—	—	1·083	See Nos. 45, 74, 75 *bis*, 81 *bis*
76	Moriori	Scott	164·6 (F_o)	153·9 (F_o)	—	—	1·070	—
77	Ancient Slavs	Rodriguez	164·5 (F_o)	153·0 (F_o)	—	—	1·075	See No. 64
78	Chinese	Brigham	—	—	164·5	—	—	See No. 108
79	Esthonians	Topinard	—	—	164·2	—	—	—
80	Ruthenians	Topinard	—	—	164·0	—	—	—
81	Caucasus, Dolmen People	Rahon	164·3	152·5	—	—	1·078	See Nos. 66, 69, 72 *bis*, 81
81 *bis*	Neolithics of Martigny	Manouvrier	164·2	150·9	—	—	1·088	See Nos. 45, 75 *bis*, 85, etc.
82	Neanderthal Man	Pearson & Bell	163·8 (F_o)	—	—	—	—	See Nos. 93, 120
83	Phoenicians and Carthaginians	Rodriguez	163·7 (F_o)	151·3 (F_o)	—	—	1·082	—
84	"Ancient Egyptians"	Rodriguez	163·4 (F_o)	155·1 (F_o)	—	—	1·054	See Nos. 12, 44
85	Neolithic Man (Mureaux)	Manouvrier	163·4	152·6	—	—	1·071	See Nos. 75 *bis*, 81 *bis*, 85, etc.
86	Maori	Hepburn, etc.	163·4 (F_o)	152·8 (F_o)	—	—	1·069	—

Table of Racial Statures (continued).

Index No.	Race	Authority for Data	Reconstruction from Long Bones ♂	Reconstruction from Long Bones ♀	Measurements on the Living ♂	Measurements on the Living ♀	Sex Ratio ♂/♀	Remarks
87	Conscript Badenser	Ecker	—	—	163·0	—	—	See Nos. 41, 59
88	Palaeolithic Man	Pearson	162·7	—	—	—	—	See Nos. 6 *a*, 29
89	Bronze Age Europeans	Rodriguez	162·5 (F_o)	147·1 (F_o)	—	—	1·105	—
90	Neolithic Man, France and Belgium	Rahon & Pearson	162·5	151·4	—	—	1·073	See Nos. 74, 75 *bis*, 81 *bis*, etc.
91	North American Indians	Rodriguez	162·1 (F_o)	148·8 (F_o)	—	—	1·089	See Nos. 7, 105
92	Fuegians	Martin and others	162·1 (F_o)	151·2 (F_o)	—	—	1·072	—
93	Man of Spy	Pearson	162·0	—	—	—	—	See Nos. 82, 120
94	Poles	Topinard	—	—	162·0	—	—	—
95	Italians from Piedmont	Topinard	—	—	162·0	—	—	See No. 100
96	Turks	Rodriguez	161·9 (F_o)	—	—	—	—	—
97	Eskimos	Hepburn, Rodriguez	161·6 (F_o)	152·9 (F_o)	—	—	1·057	See No. 109
98	Basques	Rodriguez	161·4 (F_o)	—	—	—	—	—
99	Malays	Rodriguez	161·1 (F_o)	147·9 (F_o)	—	—	1·089	—
100	Sicilians	Topinard	—	—	161·0	—	—	See No. 95
101	Neolithic Man, Breuil	Manouvrier	160·9	150·7	—	—	1·068	See Nos. 74, 75 *bis*, 90, etc.
102	Indo-Chinese	Rodriguez	160·7 (F_o)	152·7 (F_o)	—	—	1·052	See Nos. 104, 108, 119
103	Hottentots	Fritsch	—	—	160·4	—	—	—
104	Hindoos	Hepburn & Rodriguez	160·0 (F_o)	152·7 (F_o)	—	—	1·048	Caste ?
105	South and Equatorial American Indians	Rodriguez	160·0 (F_o)	147·4 (F_o)	—	—	1·085	See Nos. 5, 6
105 *bis*	Neolithics (Chamblands)	Schenk	160·0 (F_o)	150·0	—	—	1·067	See Nos. 74, 75 *bis*, 90, 101
106	Samoyedes	Topinard	—	—	159·0	—	—	See Nos. 97, 109, 118
107	Annamites	Topinard	—	—	158·9	—	—	See No. 119
108	Chinese	Rodriguez	158·8 (F_o)	151·2 (F_o)	—	—	1·050	See Nos. 78, 102
108 *bis*	Prehistoric Columbians	Antony & Rivet	158·5 (F_o)	145·4 (F_o)	—	—	1·090	—
109	Eskimos	Sutherland	—	—	158·5	152·8	1·036	See No. 97
110	Sardinians	Topinard	—	—	158·0	—	—	See Nos. 95, 100
111	Japanese	Koganei & Rodriguez	157·9 (F_o)	146·3 (F_o)	—	—	1·079	See Nos. 108, 113
112	Tilbury Man	Pearson & Bell	157·5 (F_o)	—	—	—	—	Possibly female
113	Aino	Koganei & Pearson	156·7	147·1	—	—	1·065	See Nos. 108, 111
114	Juags of Oriva	Short	—	—	156·0	—	—	—
115	Laplanders	Hepburn & Rodriguez	155·2 (F_o)	142·9 (F_o)	—	—	1·086	See No. 122
116	Negritos	Rodriguez	153·3 (F_o)	144·4 (F_o)	—	—	1·062	—
117	Veddahs	Bailey	—	—	153·0	—	—	See No. 73
118	Ostiahs	Topinard	—	—	153·0	—	—	—
119	Siamese	Topinard	—	—	152·5	—	—	See No. 107
120	*Homo mousteriensis* (*Hauseri*)	Pearson	152·4 (F_o)	—	—	—	—	From cast. See No. 82
121	Andamans (I)	Hepburn	152·3 (F_o)	143·9 (F_o)	—	—	1·058	See Nos. 123, 124
122	Laplanders	Montegazza	—	—	152·3	145·0	1·050	See No. 115
123	Andamans (II)	Man	—	—	149·2	140·3	1·063	See Nos. 121, 124
124	Andamans (III)	Pearson	147·6	144·3	—	—	1·023	See Nos. 121, 123
125	Bushmen I	Fritsch	—	—	144·4	140·4	1·028	See No. 126
126	Bushmen II	Pearson	146·0	142·0	—	—	1·028	See No. 125
127	Aigtas of Luzon	Marche & Montano	—	—	144·1	138·4	1·041	—
128	Neolithic Swiss Dwarfs	Kollmann & Pearson	148·0 (?)	141·0 (?)	—	—	1·050 (?)	See No. 105 *bis*
129	35 Bavarian Super-dwarfs	Ranke	—	—	133·9	—	—	—
130	Akkas	Pearson	120·0	124·0	—	—	·968 (!)	—
131	4 Dwarfs (< 125)	Pearson	106·6	—	—	—	—	—

II. *Obliquity of the Femur.*

We have already indicated reasons for discarding the pseudo-obliquity of Dr Warren (p. 31) and an examination of any of our tables (as that for Primogenial man and his comparatives in the following chapter) suffices to emphasise the great divergence between the real and the pseudo-obliquity. If we consider the true obliquity only we find that it has been tabled for a fairly wide range of races, but that very few conclusions have so far been deduced from its values. Our own view is that the accuracy of its determination by the mechanically badly designed osteometer of Broca (which has been customarily used) is not very great, and that until there is an international convention as to what is to be considered the "axis of the shaft" increased accuracy can hardly be expected (pp. 20 ftn. and 30). Thus any inferences to be drawn from the following table must be from such large differences that the wide variation due to errors of measurement and to personal equation in measurement must be of a secondary character[1].

The general results of this table appear to confirm our conclusions based on English data, namely that the female exceeds the male in the obliquity of the femur, and the left member exceeds the right. These results are especially noteworthy in the relatively long series of Portuguese femora provided recently by Tamagnini and Vieira de Campos. It is also confirmed for sexual difference by Schwerz in his results for the Swiss Alemanns.

That three degrees should cover practically the whole range of racial data—excluding Australians, anthropoids and primogenial man—shows how little racial differentiation can be based on this character. It has probably been of such importance as to be most stringently selected, and it is clear that only very long series are of any value for racial purposes.

The low value of the obliquity in primogenial man is one of the few instances in which he is clearly closer to the apes than more recent man. In this respect the Trinil femur is not apelike and stands far closer to modern man than to the apes.

III. *Torsion of the Femur.*

We have already referred at considerable length to the various methods which have been used to determine the Torsion of the femur, and seen how open to objection many of them are (see pp. 23—30). This variety of method supplemented by a very large factor of personal equation renders all interracial comparisons of Torsion subject to suspicion, and no marked emphasis must be laid on racial differences, not deter-

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[1] A good illustration of the danger of relying on small series may be found in the data for Fuegians. Hultkrantz's data for eight femora give mean obliquity 10°·6 which would bring them second on our list of existing races. Martin's data for five femora give a mean of 8°, which places them at the bottom of our list. The mean of the 13 bones is 9°·6 or exactly at the mid-point of the list! Such results as these ought to warn the anthropologist of the dangers which arise from arguments based on small numbers.

Table IV. *Obliquity of Femur.*

Race	♂ R.	♂ L.	♂ R. + L.	♀ R.	♀ L.	♀ R. + L.	♂ + ♀	Remarks
Gorilla	—	—	2°·9 (4)	—	—	0°·4 (3)	1°·8 (7)	We are unaware of any full series of obliquity determinations in the apes. But from the examination of other specimens we are fairly certain that the obliquity is on the average small
Chimpanzee	—	—	—	—	—	—	−0°·1 (2)	
Orang-utan	—	—	—	—	—	5°·2	4°·8 (5)	
Gibbon	—	—	—	—	—	—	5°·3 (3)	
Dryopithecus rhenanus	—	—	—	—	—	—	4°·0 (1)	
Pithecanthropus erectus	—	—	—	—	—	—	12°·0 (1)	Determined from photograph only
Neanderthal	—	—	—	—	—	—	5°·5 (1)	From cast These as most of our other measurements differ from those of Klaatsch
Spy	—	—	—	—	—	—	7°·0 (1)	From cast
Man from La Chapelle-aux-Saints	—	—	—	—	—	—	3°·0 (1)	From photographs
Homo mousteriensis (*Hauseri*)	—	—	—	—	—	—	1°·0 (1)	From cast
Homo aurignacensis (*Hauseri*)	—	—	—	—	—	—	7°·9 (1)	From photographs
Galley Hill	—	—	—	—	—	—	8°·5 (1)	From cast
Australian Natives	—	—	15°·2 (2)	—	—	12°·8 (2)	14°·0 (4)	Pearson
Modern Swiss	—	—	—	—	—	—	11°·0 (30)	Schwerz (sex unknown): see Bibl. No. 107
Swabians from Row Graves	10°·4 (12)	10°·7 (13)	10°·6 (25)	9°·3 (6)	11°·5 (5)	10°·3 (11)	10°·5 (36)	Lehmann-Nitsche: Bibl. No. 69
17th century Londoners	8°·7 (218)	11°·6 (233)	10°·2 (451)	9°·4 (166)	11°·8 (175)	10°·6 (341)	10°·4 (792)	Present Memoir
Bajuvars from Row Graves	—	—	—	—	—	—	10°·3 (10)	Lehmann-Nitsche: Bibl. No. 69
Neolithic French (Châlons-sur-M.)	—	—	10°·2 (22)	—	—	10°·5 (9)	10°·3 (31)	Manouvrier: Bibl. No. 71 *bis*
Indians of Paltacalo (Prehistoric Columbians)	9°·8 (30)	9°·9 (30)	9°·8 (60)	9°·5 (17)	10°·7 (17)	10°·1 (34)	10°·0 (94)	Antony and Rivet: Bibl. No. 97, pp. 381 and 383
Modern Bavarians	10°·3 (120)	9°·3 (105)	9°·8 (225)	(♂ + ♀)	—	—	9°·8 (225)	Bumüller: Bibl. No. 81, S. 70
Rothwell English	—	—	9°·4 (168)	—	—	10°·5 (99)	9°·8 (267)	Parsons: Bibl. No. 111
Swiss Alemanns	—	—	9°·4 (c. 164)	—	—	10°·0 (c. 164)	9°·7 (c. 328)	Schwerz: Bibl. No. 103
Modern Swiss	—	—	—	—	—	—	9°·7 (23)	Schwerz: Bibl. No. 103
Neolithic Swiss Dwarfs	—	—	—	—	—	—	9°·7 (3)	Schwerz: Bibl. No. 103
Portuguese	8°·6 (72)	9°·6 (62)	9°·1 (134)	9°·8 (63)	10°·5 (63)	10°·1 (126)	9°·6 (260)	Tamagnini and Vieira de Campos: Bibl. No. 118, p. 49
Fuegians	—	—	—	—	—	—	9°·6 (13)	Martin: Bibl. No. 63. Hultkrantz: Bibl. No. 85
Neolithic Swiss (Chamblands)	—	—	9°·7 (16)	—	—	9°·3 (10)	9°·5 (26)	Schenk: Bibl. No. 91 *bis*
Maori	—	—	—	—	—	—	9°·2 (5)	Mollison: Bibl. No. 100
Modern Viennese	—	—	—	—	—	—	9°·0 (100)	Mikulicz: Bibl. No. 22
Anau (Ancient Persians)	—	—	—	—	—	—	8°·0 (2)	Mollison: Bibl. No. 99

mined by the same process, and by the same observer[1]. On p. 30 of the present memoir we have pointed out how the main factor in torsion of the human femur is that of the shaft, the so-called torsion of the femur being this torsion of the shaft reduced by the retorsion of the head and neck. On pp. 136—140 we have touched upon the relation of torsion and retorsion to the upright position in man and woman. From the standpoint of uprightness the following figures seem suggestive:

Mean Values.

	Apes	Primogenial Man	Modern Man
Torsion of Shaft ...	8°·2	23°·3	25°·6
Retorsion	8°·7	13°·2	10°·3

Our figures are based on small numbers, so that there is little emphasis to be placed on the apparent divergence between the retorsion in primogenial and modern man. On the other hand the torsion of the shaft in man has nearly three times the value it has for the ape, while the *average* retorsion for the ape is greater than the torsion. This is not true for the gorilla, but it is markedly true for the orang-utan and occasionally for the chimpanzee. The gibbons we have measured show a torsion of the neck and head in the same sense as that of the shaft, but this is slight and, if the rule, needs fuller confirmation. Is the gorilla more upright than the chimpanzee and the chimpanzee than the orang-utan—is the order of uprightness the order of femoral torsion? Apart from difference of method and personal equation the torsional are the most variable characters of the femur, their coefficients are twice as great as those of any other characters, and in the case of most other characters 6 to 10 times as great[2]. Torsion of this bone is therefore a fluent character either subject

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[1] The following measurements will serve to emphasise these points:

	Spy (R.)	Neanderthal (L.)
Klaatsch	12°·0	9°·5
Rivet	20°·0	13°·0
Rodriguez	13°·5	—
Present Memoir ...	6°·0	16°·0

The present writers were working on the casts, but this was probably the case with Rivet and Bello y Rodriguez also. The difference between Rivet and Rodriguez is striking as they probably both used the French method. Our method is very different. What method was used by Klaatsch we cannot say. We regret, however, to have to state that we have little confidence in his accuracy of measurement.

[2] See our Table III, p. 164. As far as we know Tamagnini and de Campos (Bibl. 118, p. 53) are the only authors besides ourselves who have calculated the variabilities of the femur. We have:

Coefficients of Variation for Torsion.

	♂	♀
17th century Londoners	R. 75·69±3·75 L. 62·41±2·74	R. 71·38±3·94 L. 54·35±2·57
Rothwell English	63·83±3·18	54·18±3·26
Modern Portuguese	66·05±3·72	87·33±5·90
Prehistoric Indians of Paltacalo ...	39·66±2·75	50·18±4·76

The values indicate a lesser variation in the uncivilised race.

to easy moulding by environment and habit, or not yet fixed by long ages of selection. From this standpoint it is of interest to note that bowing, which is 50 per cent. greater in primogenial than in modern man, has a variation only second to that of torsion (see Table IV, p. 165 and the Table of the Measurements of the Femora of Primogenial Man in Chapter X).

In the following table we place together all the torsional results we have been able to collect, again warning the reader of the heterogeneity of method which has been used in their determination[1]. For example the two groups of modern French and the two groups of Negroes measured by different authorities are unpleasantly wide apart. The prehistoric and primitive races, the modern European races, the Asiatics or the Americans do not give groups whose members fall markedly together. If we term above 24° very high torsion, 24° to 18° high torsion, 18° to 12° moderate torsion, 12° to 6° low torsion and below 6° very low torsion; then the apes are found in very low and low torsional ranges; primogenial man on the border of very low and low torsion; modern Europeans and most of their progenitors in moderate torsion; Guanches, Eskimos, Fuegians, Negroes, Negritos and Melanesians in the high torsional range; while the Polynesians are associated with Cromagnon, Maori and certain neolithic femora in the very high torsion group. We cannot, however, assert that the more primitive the race the higher the torsion, for certain primitive races like the Lapps and Veddahs appear to have extremely low torsion, in value more nearly that of the apes. Thus although the table does seem to indicate that torsion has some racial weight, there is no obvious evolutionary torsional classification and we might even anticipate local habit as enforced by environment having considerable influence on this femoral character. It would be of interest to have some measure of upright bearing applied to primitive races in order to test whether this has any relation to torsion.

Authoritative determinations of torsion of shaft and of retorsion in the apes, in primogenial man and in primitive man are very desirable. Methods of measurement badly need standardising, and it is far from adequate to define torsion as the angle between a certain "condylar axis" and the projection on the standard horizontal plane of the "axis of the neck," if these axes themselves are not more exactly defined.

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[1] The majority of the authors dealt with do not state whether they have met with *negative* torsions, and if so how they have treated them. We note that Mikulicz (Bibl. 22, S. 376) is an exception to the rule. From his data for 120 (probably ♂) Viennese femora we find the angle of torsion ignoring sign 12°·95 and regarding sign 11°·57, a much greater difference than we have obtained for 17th century Londoners: see Tables IV and V, Chapter IV.

TABLE V. *Torsional Angles of the Femur.*

Race	♂ R.	♂ L.	♂ R.+L.	♀ R.	♀ L.	♀ R.+L.	♂ + ♀	Remarks
Gorilla	—	—	—	—	—	—	6°·3 (54)	Present authors, Hepburn, Rodriguez, Antony and Rivet
Chimpanzee	—	—	—	—	—	—	4°·7 (31)	,, ,, ,, ,,
Orang-utan	—	—	—	—	—	—	–4°·4 (6)	,, ,, ,, ,,
Gibbon	—	—	—	—	—	—	8°·3 (28)	,, ,, ,, ,,
Dryopithecus rhenanus	—	—	—	—	—	—	13°·5 (1)	Present authors, from cast
Pithecanthropus erectus	—	—	—	—	—	—	15°·0 (1)	Dubois, Bibl. No. 67 *bis*, S. 23
Neanderthal	—	—	—	—	—	—	6°·0 (1)	Present authors, from cast
Spy	—	—	—	—	—	—	16°·0 (1)	,, ,, ,,
Homo mousteriensis (*Hauseri*) ...	—	—	—	—	—	—	8°·5 (1)	,, ,, ,,
Man of La Ferassie II	—	—	—	—	—	—	18°·0	Rivet in Boule: see Bibl. No. 106 *bis*
Maori	—	—	—	—	—	—	39°·7 (4)	Mollison, Bibl. No. 100
"Cromagnon"	—	—	—	—	—	—	35°·0 (13)	Rodriguez speaks of 13, probably bones which are called of that type
Neolithic Man (Châlons-sur-Marne)	—	—	29°·0 (23)	—	—	27°·3 (10)	28°·6 (38)	Manouvrier, Bibl. No. 71 *bis*, p. 162
Ancient Persians (Anau) ...	—	—	—	—	—	—	27°·0 (2)	Mollison, Bibl. No. 99
Polynesians	—	—	—	—	—	—	27°·2 (18)	Rodriguez, Bibl. No. 101
Prehistoric (Naqada) Egyptians	—	—	21°·7 (33)	—	—	26°·1 (80)	24°·8 (113)	Warren, Bibl. No. 77
Negritos	—	—	—	—	—	—	23°·0 (42)	Rodriguez, Bibl. No. 101
Californian Indians	—	—	—	—	—	—	23°·1 (122)	,, Bibl. No. 101
Ancient Egyptians	—	—	—	—	—	—	22°·8 (22)	,, Bibl. No. 101
Melanesians	—	—	—	—	—	—	22°·8 (80)	,, Bibl. No. 101
Patagonians	—	—	—	—	—	—	22°·0 (101)	,, Bibl. No. 101
Indonesians	—	—	—	—	—	—	21°·0 (14)	,, Bibl. No. 101
Negroes I (locus?)	—	—	—	—	—	—	20°·7 (13)	Manouvrier, Bibl. No. 26
Fuegians	—	—	—	—	—	—	19°·8 (27)	Hultkrantz, Martin, Rodriguez
Eskimos	—	—	—	—	—	—	19°·2 (16)	Rodriguez, Bibl. No. 101
Indians of Paltacalo	—	—	19°·1 (62)	—	—	19°·2 (38)	19°·1 (100)	Antony and Rivet, Bibl. No. 98 *bis*
Berbers and Guanches	—	—	—	—	—	—	18°·5 (94)	Rodriguez, Bibl. No. 101
Neolithic Man (France)	—	—	—	—	—	—	18°·5 (240)	,, Bibl. No. 101

TABLE V. *Torsional Angles of the Femur* (continued).

Race	♂ R.	♂ L.	♂ R.+L.	♀ R.	♀ L.	♀ R.+L.	♂ + ♀	Remarks
Central American Indians (Ancient) ...	—	—	—	—	—	—	18°·24 (242)	Rodriguez's Data (pooled)
Malays	—	—	—	—	—	—	17°·4 (118)	Rodriguez, Bibl. No. 101
Negroes II	—	—	—	—	—	—	17°·4 (97)	,, Bibl. No. 101
Modern French	—	—	—	—	—	—	17°·2 (79)	Manouvrier, Bibl. No. 26
Ancient Phoenicians and Carthaginians	—	—	—	—	—	—	16°·8 (16)	Rodriguez, Bibl. No. 101
Turks	—	—	—	—	—	—	16°·3 (18)	,, Bibl. No. 101
Bavarians	—	—	—	—	—	—	16°·4 (152)	Bumüller, Bibl. No. 81
Ainos	—	—	—	—	—	—	15°·7 (8)	Rodriguez, Bibl. No 101
Hindoos	—	—	—	—	—	—	15°·7 (18)	,, Bibl. No. 101
Men of Bronze Age	—	—	—	—	—	—	15°·5 (46)	,, Bibl. No. 101
Canary Femora (? Modern) ...	—	—	—	—	—	—	15°·3 (287)	,, Bibl. No. 101
Ancient Peruvians	—	—	—	—	—	—	15°·2 (75)	,, Bibl. No. 101
Indo-Chinese	—	—	—	—	—	—	15°·0 (16)	,, Bibl. No. 101
Rothwell English	—	—	13°·27 (166)	—	—	17°·22 (100)	14°·76 (266)	Parsons, Bibl. No. 111
17th century Londoners ...	11°·63 (199)	14°·71 (210)	13°·21 (409)	14°·24 (151)	17°·90 (162)	16°·13 (313)	14°·48 (722)	Present Memoir
Modern French	—	—	—	—	—	—	14°·4 (69)	Rodriguez, Bibl. No. 101
Merovingians	—	—	—	—	—	—	14°·0 (140)	,, Bibl. No. 101
Ancient Slavs	—	—	—	—	—	—	13°·8 (43)	,, Bibl. No. 101
Mediaeval French	—	—	—	—	—	—	13°·6 (183)	,, Bibl. No. 101
Swiss Alemanns	—	—	12°·1 (c. 82)	—	—	15°·0 (c. 82)	13°·5 (164)	Schwerz, Bibl. No. 107
Chinese	—	—	—	—	—	—	13°·4 (6)	Rodriguez, Bibl. No. 101
Modern Germans	—	—	—	—	—	—	13°·4 (18)	,, Bibl. No. 101
Neolithic Swiss Dwarfs	—	—	—	—	—	—	12°·7 (3)	Schwerz, Bibl. No. 103
Gauls and Romano-Gauls ...	—	—	—	—	—	—	12°·8 (78)	Rodriguez, Bibl. No. 101
Modern Swiss	—	—	—	—	—	—	12°·7 (14)	Schwerz, Bibl. No. 107
Basques	—	—	—	—	—	—	12°·3 (35)	Rodriguez, Bibl. No. 101
Recent Swiss	—	—	—	—	—	—	12°·2 (14)	Schwerz, Bibl. No. 103
Portuguese	12°·19 (72)	11°·63 (62)	11°·93 (134)	11°·95 (63)	11°·57 (63)	11°·76 (126)	11°·85 (260)	Tamagnini and de Campos, Bibl. No. 118
Modern Viennese	—	—	—	—	—	—	11°·87 (120)	Mikulicz, Bibl. No. 22
Japanese	—	—	—	—	—	—	11°·5 (49)	Rodriguez, Bibl. No. 101
Franks and Burgundians ...	—	—	—	—	—	—	11°·2 (30)	,, Bibl. No. 101
Bajuvars, Swabians and Alemanns from Row Graves	—	—	8°·6 (23)	—	—	14°·9 (5)	9°·7 (28)	Lehmann-Nitsche, Bibl. No. 69
Lapps	—	—	—	—	—	—	8°·6 (6)	Rodriguez, Bibl. No. 101
Veddahs	—	—	—	—	—	—	0°·2 (2)	,, Bibl. No. 101

IV. *Pithecoid Index.*

It is a well recognised feature of the simian femur as compared with that of man, that when the femur is adjusted to the standard horizontal and vertical planes the great trochanter stands almost at the same level as or even above the head. This rule is not absolutely universal; even in the anthropoids the orang is an exception, and among the monkeys Ateles and a few others are also anomalous. But it is so nearly the universal rule that it is desirable to measure the characteristic numerically. A suitable index is easily found. The height of the trochanter above the standard horizontal plane is the oblique trochanteric length, and the corresponding height of the top of the head is the oblique length. The ratio of these two lengths will suffice to mark the pithecoid character of the femur. Accordingly we term the expression 100 × trochanteric oblique length/oblique length the *Pithecoid Index.* In the following table such values of the pithecoid index as we have been able to ascertain are given for the apes and for various races of man.

The results of this table are of very great interest. The fundamental point is the exceedingly small range of variation in Recent Man. If we allow for the very small samples and the personal equation of sexing and measurement there is small doubt that 95·25, our result for the 17th century London population, will stand quite adequately as representing the pithecoid index in Recent Man. There is some evidence, as in a number of tables for other characters, that modern civilised man cuts into the middle of the range of values for prehistoric man and modern uncivilised races. There is again some evidence that neolithic man had a more simian femur than modern man, and than the primitive races of Australasia[1].

Turning now to Primogenial Man, we note that *Pithecanthropus erectus* is not in the least pithecoid in this character; its index is essentially that of modern man and not that of the gibbon. Taken as a whole Primogenial Man gives a pithecoid index of 96·9 as against the 95·2 of Recent Man. He was thus somewhat nearer the anthropoids, which give a mean of 97·5, or, if we include the gibbon, of 98·0. But the comparison is somewhat fallacious, because for this character the orang is less apelike than Recent Man and *a fortiori* than Primogenial Man. We see that Primogenial Man was in this respect almost exactly midway between the chimpanzee and the orang. The gorilla maintains the essentially pithecoid value of 100·0, and shows this apelike feature with all the Old World lesser apes. The New World monkeys have a somewhat less pithecoid index than the Old World, as we might perhaps anticipate. Thus we have:

$$\text{Lemuroids}\quad 100{\cdot}3 \begin{cases} \text{Old World Monkeys} & 101{\cdot}7, \\ \text{New World Monkeys} & 98{\cdot}8. \end{cases}$$

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[1] It is a grave misfortune that Prochownick has measured neither the trochanteric oblique length or the diameters of the shaft of his Australian skeletons, nor have we been able to discover any other material for the Australian femur bearing on this point. It would have been very suggestive as a means of determining whether the Australian femur is not further from the Neanderthal type (*i.e.* more like the Moriori femur as we suspect) than European neolithic man is. Since writing the above the suspicion expressed has been strengthened by four Australian femora which have come into the possession of one of the present writers.

TABLE VI. *Pithecoid Index.*

	Race	Index Value ♂ ♀	Source of Data
Lemuroidea	Tarsiidae	99·6 (2)	Authors
	Lorisinae	98·4 (6)	"
	Galaginae	99·9 (6)	"
	Lemurinae	102·0 (18)	"
	Indrisinae	101·9 (8)	"
	Chiromyrdae ...	99·3 (2)	"
Cebidae	Hapalinae	100·1 (16)	"
	Nyctipithecinae ...	99·2 (8)	"
	Brachyurus	99·4 (2)	"
	Pithecia	98·1 (2)	"
	Mycetes	98·1 (2)	"
	Cebus	99·5 (6)	"
	Lagothrix	98·3 (2)	"
	Ateles	97·6 (4)	"
Simiadae	Cynocephalus ...	102·6 (8)	"
	Macacus	101·4 (14)	"
	Cercocebus	101·8 (4)	"
	Cercopithecus ...	101·3 (8)	"
	Semnopithecus ...	101·2 (10)	"
Simiinae	Gibbon	99·3 (2)	"
	Dryopithecus rhenanus	99·2 (1)	Cast
	Gorilla	100·85 (4) 99·1 (3)	Authors
	Chimpanzee	100·0 (2)	"
	Orang	92·7 (5)	"

Race	Index Value ♂ ♀	Source of Data
Pithecanthropus erectus	95·6 (1)	Photographs
PRIMOGENIAL MAN:		
Neanderthal Type	96·7 (6)	Various
Cromagnon Type	97·1 (5)	Various
Galley Hill	?	—
Grimaldi Type	97·1 (2)	Verneau
Homo aurignacensis (*Hauseri*) ...	96·2 (1)	Photographs
RECENT MAN:		
Neolithic Swiss Dwarfs	96·3 (4)	Schwerz
Bajuvars from Row Graves ...	96·0 (16) 95·6 (7)	Lehmann-Nitsche
Fuegians (I)	95·7 (5)	Martin
Neolithic French	95·7 (11) 94·9 (4)	Manouvrier & Antony
17th century Londoners	95·3 (367) 95·2 (285)	Present Memoir
Ancient Columbian Indians ...	95·1 (50) 95·5 (34)	Antony & Rivet
Ancient Persians from Anau ...	94·9 (2) —	Mollison
Modern Swiss	94·7 (21)	Schwerz
Swabians and Alemanns from Row Graves ...	93·8 (15) 97·8 (6)	Lehmann-Nitsche
Fuegians (II)	94·6 (8)	Hultkrantz
Maori (I)	94·5 (6)	Mollison
Maori (II)	94·3 (17) 93·9 (7)	Scott
Moriori	93·1 (6) 94·3 (3)	Scott
Australian Natives	93·9 (2) 92·3 (2)	Pearson

In this, as in some other respects, the New World monkeys seem nearer to man than the Old World monkeys, and the femur of Ateles is in certain respects more human than that of the gibbon. We shall return to the general problem of the interrelation of the femora of ape and man in Chapter X, but meanwhile we have in this section endeavoured to emphasise the importance of determining in all cases the oblique trochanteric length on which the pithecoid index depends. Our table indicates that for this character the step from Primogenial Man to an intermediate of the chimpanzee and orang would not be greater than the step from Primogenial to Recent Man. The low value of the index in the case of the orang at least indicates that in the ancestry of the anthropoids there was an element with a marked tendency to lower the height of the great trochanter to even a greater extent than we find in man, *i.e.* the low trochanter is not a purely human feature.

V. *Index of Robusticity of the Femur.*

The comparative material is here relatively ample, but is principally due to Rodriguez, who provides no sex differentiation. Unfortunately some of the series with high robusticity, and therefore of greatest interest, are so short that we cannot lay much stress on the position they take in the racial scale. Other factors more or less vitiate individual results; thus Kuhff has discarded femora with marked torsion, and he further takes his pilastric section at the level of the upper nutritive foramen, a very variable position. On the other hand, Parsons has taken an individual line; he adopts no pilastric section, but takes the maximum antero-posterior and *minimum* transverse diameter of the shaft wherever they occur, presumably if they are found at widely separated shaft sections[1]. The result appears to be manifest in the high value of the pilastric index as deduced from his material. This choice of diameters should have tended to reduce his robusticity, but this is not the case. His value for the Rothwell males would place the English mediaeval femur at the head of all the Recent Man series, and closest to that of Primogenial Man. Frankly, we do not believe in such a position for the English; it is not confirmed by our own value for the robusticity, which is in reasonable accordance with Hepburn's, and both are only slightly in excess of Rodriguez's for modern Germans and French, Tamagnini and de Campos' for modern Portuguese and Schwerz's for modern Swiss. To confirm the error in Parsons' position for the British femur we may take the data provided by Holtby for 100 femora in the anatomical school at Dublin. After reduction based upon his "least transverse diameter of the shaft," which should correspond to Parsons' transverse diameter, we find:

Index of Robusticity: Males, 12·76 (56); Females, 12·53 (44), comparing well with our 17th century Londoners:

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[1] "Evil communications corrupt good manners"—and this novel manner of taking the pilastric transverse has been followed by Tamagnini and de Campos in their, in many respects, excellent paper on the Portuguese femur (Bibl. 118, p. 239). More recently Holtby, measuring femora in the anatomy school in Dublin (Bibl. 119, p. 372), has apparently reverted to the standard method of determining the pilastric transverse, but the only value he tables for the mid-shaft diameters is, like Parsons, the "Least transverse diameter of the shaft" (*loc. cit.* pp. 380—2).

Males, 12·84 (417); Females, 12·57 (325).

The slight change in the French femur's robusticity within historical times does not suggest any change in two or three centuries such as Parsons' figures demand. We are compelled to the conclusion that there has been a marked selection of the more robust femora in his material, which renders it of small value for interracial comparisons.

There are other difficulties also in our table (p. 250) as it stands. Notably the outliers at both ends are obtained as a rule from very short series, and the grave doubt arises as to how far their position may not be due to the errors of small samples. Tarenetzsky's Aleuts belong to two skeletons only, ♂ and ♀, of which he seems in each case to have measured the R. femur only. Now the Aleuts are a fringe people of transcending interest—and they are in the scale just where we should anticipate that they should be—but it certainly would not be wise to assume that the position occupied is the true one until more data are available. Again, Koganei's Aino, Rodriguez's Japanese and Scott's Moriori are in by no means unreasonable positions. But we find that Koganei's Japanese and Rodriguez's Aino flatly contradict these results. Koganei's sample of modern Japanese is, however, much smaller than Rodriguez's, and Rodriguez's Aino sample consists only of 8 femora. We think both are probably misplaced, but until further large samples of Aino and of modern Japanese are available, we cannot definitely settle the point. The same difficulty occurs with the two series of Laplanders, and here again it seems to us more probable that Rodriguez's short series is better placed than Hepburn's still shorter one.

With all due reserve the table seems to indicate in Recent Man the following broad lines of suggestion. A short thick-boned race of men pushed out to the extremes of the earth, there to be differentiated in many respects but to retain in others similarity—this race is represented by the existing "fringe peoples" such as Fuegians, Moriori, Eskimo, Aleuts, Aino and to a less extent by Laplanders and Japanese. It may be convenient to speak of the progenitors of these "fringe peoples" as *Protoneoteric Man*—the original type of recent man. The table provides some evidence that neolithic man was somewhat nearer in femoral robusticity to this protoneoteric man than modern civilised man.

At the other end of the table we find the Asiatics and Africans with relatively slender femora. In particular the black races in all their branches, as far as the femur is concerned, are further removed than the modern white from primogenial man. As in several other cases the Europeans with their historic and prehistoric forbears occupy the centre of the table, flanked on the one side by the fringe races to which we have just referred and on the other by Australasians, Polynesians and Asiatics in the roughest of geographical orders. The ancient Egyptian appears rather as a link between Asiatic and African, than between African and European[1]. In the quality of robusticity the Egyptian, the Negro, and for the matter of that, the Australian, cannot be considered inferior to or more primitive than the modern European, if inferiority or primitiveness be measured by approach to the fringe races or to our Protoneoteric Man, as the nearest akin of Recent Man to Primogenial Man.

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[1] Cf. Warren, Bibl. 77, p. 191.

For the American Indians we have no data for the northern races, but—picked out from the Europeans and Asiatics—Fuegians 12·8 to 12·9, Patagonians 12·7, Equatorial and South American Indians 12·6, and ancient New Mexico Indians 12·0 form a fairly continuous series between the South American fringe people and the low robusticity of the eastern Asiatics and suggest connecting links.

Passing now to the question of Primogenial Man we find at once the old difficulties which attach to *Homo aurignacensis* (*Hauseri*) and to Galley Hill. The former is wholly modern in robusticity, the latter appears by its index modern, but we hold any measurement on the pilastric section of this femur of very little value for reasons elsewhere stated (see our Chapter X). On the other hand the Cromagnon type, which is based on what material we could deduce from five examples, is undoubtedly low. The explanation is, however, at once forthcoming: the Cromagnon femur has a most massive midshaft region but its extreme length greatly reduces its relative robustness. It is as we have indicated a great stride towards the femur of Recent Man, but it is on a much bigger scale. This is again illustrated in Rodriguez's value of 12·3 for the robusticity of the Cromagnon type. It appears to us to be too small a value, but we have no means of checking it as he does not give any details of the 13 individuals he claims to be of this type. We should expect to find the robusticity of the Grimaldi type much that of the Cromagnon and of our suggested Protoneoteric Man. Unfortunately we can nowhere find the magnitude of the pilastric antero-posterior diameter of Verneau's Grimaldi type, and he gives no photograph of his femora from the lateral aspect[1]. The Neanderthal type stands in robusticity where we should anticipate it—intermediate between the greater anthropoids and recent man.

Once again the Trinil femur is seen to be purely human, and while not so far distant from the Eppelsheimer femur, which has itself human robusticity, it is widely remote from recent gibbons. As in the case of the pithecoid index it is the orang among the greater anthropoids which shows the human tendency—the gorilla is far removed from the rest of the primates; but the order greater anthropoids, primogenial man, recent man holds as for the pithecoid index. The general values are:

Old World Monkeys 13·25,
Lemuroids 11·45
New World Monkeys 11·50.

The greater anthropoids with 16·28 are closer in this character to the Old World monkeys—the gibbon being, as in the case of the pithecoid index, remote from man and from the other anthropoids. Primogenial Man—at least of the Neanderthal type—has a robusticity intermediate between the greater anthropoids and the Old World

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[1] A letter to Professor Verneau asking whether it would be possible to obtain one or two further measurements of these femora either failed to reach him or received no reply.

TABLE VII. *Index of Robusticity of the Femur.*

	Race	Value of Index ♂	♀	Source of Data
Lemuroidea	Tarsiidae	9·9 (2)		Authors
	Lorisinae	12·1 (6)		,,
	Galaginae	12·6 (6)		,,
	Lemurinae	12·1 (18)		,,
	Indrisinae	10·2 (8)		,,
	Chiromyrdae ...	11·8 (2)		,,
Cebidae	Hapalinae	12·1 (16)		,,
	Nyctipithecinae ...	10·3 (8)		,,
	Brachyurus	9·3 (2)		,,
	Pithecia	10·3 (2)		,,
	Mycetes	12·1 (2)		,,
	Cebus	11·2 (6)		,,
	Lagothrix	14·4 (2)		,,
	Ateles	12·2 (4)		,,
Simiadae	Macacus	14·3 (14)		,,
	Cynocephalus ...	14·0 (8)		,,
	Cercocebus	12·3 (4)		,,
	Cercopithecus ...	13·7 (8)		,,
	Semnopithecus ...	11·9 (10)		,,
Simiinae	Gibbon	9·4 (2)		,,
	Dryopithecus rhenanus	12·3 (1)		Cast
	Gorilla	18·9 (4)	18·0 (3)	Authors
	Chimpanzee	15·5 (2)		,,
	Orang-utan	14·9 (5)		,,

Race	Value of Index ♂	♀	Source of Data
Pithecanthropus erectus	12·7 (1)		Photographs & Dubois
PRIMOGENIAL MAN:			
Neanderthal Type	14·3 (6)		Various
Galley Hill	12·4 (1)?		Cast
Cromagnon Type	13·0 (5)		Various
Grimaldi Type	?		—
Homo aurignacensis (*Hauseri*) ...	12·6 (1)		Photographs & Klaatsch
RECENT MAN:			
Andamans	11·2 (12)		Hepburn
Sandwich Islanders	11·5 (5)		,,
Hindoos I	11·6 (8)		,,
Ancient Egyptians	11·7 (22)		Rodriguez
Indo-Chinese	11·75 (16)		,,
Negroes I	11·75 (11)		Hepburn
Negroes II	11·8 (97)		Rodriguez
Melanesians	11·8 (80)		,,
Romano-British	11·8 (5)		Hepburn
Maori I	11·9 (15)		,,
Hindoos II	11·9 (18)		Rodriguez
New Mexico Indians (Saladonians)	12·0 (131)		Mathews & Workman
Polynesians	12·1 (18)		Rodriguez
Veddahs I	12·1 (2)		,,
Malays	12·1 (118)		,,
Bushmen	12·1 (1)		Hepburn
Negritos	12·1 (42)		Rodriguez
Maori II	12·2 (17)	12·2 (8)	Scott

<table>
<tr><th rowspan="2">Race</th><th colspan="2">Value of Index</th><th rowspan="2">Source of Data</th><th rowspan="2">Race</th><th colspan="2">Value of Index</th><th rowspan="2">Source of Data</th></tr>
<tr><th>♂</th><th>♀</th><th>♂</th><th>♀</th></tr>
<tr><td>Recent Man (<i>continued</i>):</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Japanese I</td><td>12·2 (20)</td><td>11·5 (20)</td><td>Koganei</td><td>Patagonians</td><td colspan="2">12·7 (101)</td><td>Rodriguez</td></tr>
<tr><td>Veddahs II</td><td>12·2 (8)</td><td>11·9 (3)</td><td>P. and F. Sarasin</td><td>Sicilian Neolithics</td><td colspan="2">12·7 (9)</td><td>Ruggieri</td></tr>
<tr><td>Chinese</td><td colspan="2">12·2 (6)</td><td>Rodriguez</td><td>Men of Bronze Age</td><td colspan="2">12·7 (46)</td><td>Rodriguez</td></tr>
<tr><td>Canary Islanders</td><td colspan="2">12·2 (287)</td><td>,,</td><td>Neolithic Swiss Dwarfs</td><td colspan="2">12·7 (4)</td><td>Schwerz</td></tr>
<tr><td>Maori III</td><td colspan="2">12·2 (8)</td><td>Mollison</td><td>Bajuvars from Row Graves</td><td>12·7 (26)</td><td>12·8 (9)</td><td>Lehmann-Nitsche</td></tr>
<tr><td>Indonesians</td><td colspan="2">12·3 (14)</td><td>Rodriguez</td><td>*French Neolithics I</td><td colspan="2">12·8 (8)</td><td>Kuhff</td></tr>
<tr><td>[Cromagnon Type</td><td colspan="2">12·3 (13)</td><td>,,]</td><td>Modern Irish (?)</td><td>12·8 (56)</td><td>12·5 (44)</td><td>Holtby</td></tr>
<tr><td>Modern Swiss</td><td colspan="2">12·3 (30)</td><td>Schwerz</td><td>17th century Londoners</td><td>12·8 (417)</td><td>12·6 (325)</td><td>Present Memoir</td></tr>
<tr><td rowspan="2">Swabians and Alemanns from Row Graves</td><td rowspan="2">12·3 (25)</td><td rowspan="2">11·7 (11)</td><td rowspan="2">Lehmann-Nitsche</td><td>Merovingians</td><td colspan="2">12·8 (40)</td><td>Rodriguez</td></tr>
<tr><td>Gauls and Romano-Gauls</td><td colspan="2">12·8 (78)</td><td>,,</td></tr>
<tr><td>Modern French</td><td colspan="2">12·3 (69)</td><td>Rodriguez</td><td>Fuegians I</td><td colspan="2">12·8 (12)</td><td>,,</td></tr>
<tr><td>Laplanders I</td><td colspan="2">12·4 (4)</td><td>Hepburn</td><td>Eskimo I</td><td colspan="2">12·9 (13)</td><td>,,</td></tr>
<tr><td>Aino I</td><td colspan="2">12·4 (8)</td><td>Rodriguez</td><td>Fuegians II</td><td colspan="2">12·9 (10)</td><td>Hultkrantz</td></tr>
<tr><td>Portuguese</td><td>12·5 (132)</td><td>12·5 (126)</td><td>Tamagnini and de Campos</td><td>Phoenicians and Carthaginians</td><td colspan="2">13·0 (16)</td><td>Rodriguez</td></tr>
<tr><td>Mediterranean Race</td><td colspan="2">12·5 (32)</td><td>Rodriguez</td><td>Moriori</td><td>13·0 (6)</td><td>12·4 (3)</td><td>Scott</td></tr>
<tr><td>Australians</td><td colspan="2">12·5 (14)</td><td>Hepburn</td><td>Ancient Slavs</td><td colspan="2">13·1 (43)</td><td>Rodriguez</td></tr>
<tr><td>Turks</td><td colspan="2">12·5 (18)</td><td>Rodriguez</td><td>Japanese II</td><td colspan="2">13·1 (92)</td><td>,,</td></tr>
<tr><td>Modern Germans</td><td colspan="2">12·5 (18)</td><td>,,</td><td>Laplanders II</td><td colspan="2">13·1 (6)</td><td>,,</td></tr>
<tr><td>Franks and Burgundians</td><td colspan="2">12·6 (30)</td><td>,,</td><td>Swiss Neolithics</td><td>13·2 (20)</td><td>12·2 (17)</td><td>Schenk</td></tr>
<tr><td rowspan="2">Equatorial and South American Indians</td><td rowspan="2" colspan="2">12·6 (452)</td><td rowspan="2">,,</td><td>Eskimo II</td><td colspan="2">13·2 (4)</td><td>Hepburn</td></tr>
<tr><td>*French Neolithics II</td><td colspan="2">13·3 (19)</td><td>Kuhff</td></tr>
<tr><td>Ancient Etruscans</td><td colspan="2">12·6 (33)</td><td>Sergi</td><td>Aino II</td><td>13·4 (46)</td><td>13·0 (26)</td><td>Koganei</td></tr>
<tr><td>Neolithic Europeans</td><td colspan="2">12·6 (240)</td><td>Rodriguez</td><td>Rothwell English</td><td>13·5 (184)</td><td>12·9 (106)</td><td>Parsons</td></tr>
<tr><td>Modern British</td><td>12·6 (39)</td><td>—</td><td>Hepburn</td><td>*Aleuts</td><td colspan="2">13·7 (2)</td><td>Tarenetzsky</td></tr>
<tr><td>Basques</td><td colspan="2">12·6 (35)</td><td>Rodriguez</td><td>Dolmens of Lozère</td><td colspan="2">13·7 (5)</td><td>Kuhff</td></tr>
<tr><td>Berbers and Guanches</td><td colspan="2">12·6 (94)</td><td>,,</td><td></td><td></td><td></td><td></td></tr>
</table>

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* For reasons previously given these are of doubtful value. Neolithic Series II was from Baye, and Neolithic Series I from the Caverne de l'Homme Mort.

monkeys, and he cannot be differentiated from the apes by this femoral character. Indeed the step from orang to Neanderthal Man is less than from the Eskimo to the Chinaman. Nor can we assert that Eskimo and Chinese femora differ as *wholes* less from each other than orang and Neanderthal femora, until we have a scientific measure for estimating the differences between two individuals judged by a multiplicity of characters. It is not hard to provide theoretically such a measure, but at present data for the correlations of the characters which it involves are too sparse to render it of value.

B. Diaphysial Characters.

VI. *Platymeric, Pilastric and Popliteal Indices.*

We devote this section of our memoir to the consideration of the cross-sections of the shaft as represented by the above indices. It has been very customary to consider these indices as uninfluenced by sex and side; thus the bulk of comparative data deals with the indices regardless of such factors. We have shown that there is in these cases considerable differentiation with sex and side, but in order to form a table for comparative racial purposes we have been compelled to pool all bones in our own series.

The pilastric index was introduced by Broca and was originally termed the *indice femoral.* A table of pilastric indices due to Broca has been published by Topinard[1]. According to Broca the quadrupeds have indices from 116 to 104, the lower races of monkeys 105 to 96, the anthropoids 95 to 77; and man 122 to 105. Thus a "scission" is made in the order of the primates, for the quadrupedal apes separate man from the anthropoids. Manouvrier endeavours to account for this[2] by remarking that man is exclusively a walker, the anthropoids are almost exclusively climbers, while the quadrupedal apes are both climbers and walkers. With one exception the average pilastric index of any human group is over 100, and the average of any anthropoid group under 100. Yet in individual cases the pilastric index in man may fall as low as 85, and we have ourselves a gorilla femur in which the pilastric index rises to 94·4 and a gibbon femur in which it rises to 105·3. In other words, the ranges of this index in man and the anthropoidal apes to a considerable extent cover each other, and the individual pilastric index—notwithstanding the "scission" in the order of the primates—is no useful criterion of what is human and what apelike.

The platymeric and popliteal indices were introduced by Manouvrier, the former to measure the flattening in the subtrochanteric region so peculiar to the Maori and Moriori femora. But platymery has not shown itself a marked character of the lower types of man, or, if it be, Australians and Negroes must be looked upon as exceptions, for they are scarcely more platymeric than modern Bavarian or Londoner. Nor is

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[1] *L'Anthropologie,* Edn. 1885, p. 1018. An extension of Broca's Table is given on our p. 270.

[2] Bibl. 57, p. 144.

TABLE VIII. *Chief Shaft Section Indices in various Races.*

Race (with oblique length of male femur)	Platymeric Index		Pilastric Index		Popliteal Index		Authorities (data drawn from)
	No.	Magnitude	No.	Magnitude	No.	Magnitude	
Lemuroidea	42	92·6	42	100·6	42	81·4	Present Authors
Cebidae	42	89·7	42	95·6	42	72·1	
Simiadae	44	96·5	44	100·8	44	79·2	
Gorilla	71	81·6	75	76·2	8	57·4	Rodriguez, Bumüller, Hepburn, Antony, Rivet and Present Authors
Orang-utan	12	72·2	17	79·4	8	63·0	
Chimpanzee	48	82·7	50	84·7	7	72·9	
Gibbon	41	86·3	45	97·1	7	81·4	
Dryopithecus rhenanus (Eppelsheim) (287·0) ...	1	91·5 —	1	98·3 100·0	1	63·5 65·4	Present Authors Bumüller
Pithecanthropus erectus (452·0)	1	93·9??	1	109·1?	1	88·9?	See footnote *
Neanderthal (419·6) ...	5	77·6	5	108·1	5	79·4	Various
Spy (426·5)	2	77·2	2	102·0	1	86·1—	Klaatsch
Grimaldi (434·0)	2	82·8	—	—	2	80·0	Verneau & Authors
Cromagnon (519)	5	73·0	5	125·1	5	81·0	Various sources
Galley Hill (423·0)	1	66·7	1	99·2	1	69·2	Pearson & Bell
Homo mousteriensis (*Hauseri*)	1	77·7	1	104·6	1	69·9	Authors from cast
Homo aurignacensis (*Hauseri*)	2	86·4	2	114·3	—	—	Klaatsch
Negroes (various) (455·4) ...	106	83·0	106	108·5	9	81·8	Rodriguez, Hepburn and others
Melanesians (444·7) ...	80	79·3	80	114·7	—	—	Rodriguez
Negritos (380·4)	42	81·8	42	116·0	—	—	Rodriguez
Hindoos (probably low caste) (415·8)	24	79·0	10	112·6	6	82·8	Rodriguez & Hepburn
Veddahs (442·5)	2	88·5	13	118·8	—	—	Sarasins & Rodriguez
Andamans (375·1)	12	78·0	12	113·5	12	77·3	Hepburn
Malays (421·8)	118	76·7	118	114·8	—	—	Rodriguez
Polynesians (448·5)	18	68·3	18	110·0	—	—	Rodriguez
Australians (467·3)	14	82·2	14	122·2	14	85·3	Hepburn
Maori (435·6)	36	65·5	38	114·3	15	77·5	Scott, Mollison and Hepburn
Moriori (440·2)	9	63·4	9	112·6	—	—	Scott
Prehistoric Mussel Heaps of Japan (—)	7	[72·7]†	13	110·4	—	—	Koganei
Aino (405·7)	81	[72·2]†	80	103·2	—	—	Koganei & Rodriguez
Japanese (406·8)	132	[77·0]	132	102·4	—	—	Rodriguez & Koganei

* Manouvrier (Bibl. 68, p. 361) gives 97·0, Hepburn (Bibl. 71, p. 2) 96·9 for the popliteal index; the former value is the more correct, if we can trust the magnitudes (33 and 32) cited by both for the popliteal transverse and antero-posterior diameters. But how did Manouvrier ascertain these? Bumüller (Bibl. 81, p. 112, Tabelle II) gives 96·97, without stating its source, but follows it with 78·4 in brackets, an indication that this latter value was obtained from Dubois' plate. We obtained a doubtful value 88·9 from the plate. Our value 93·9 for the platymeric index is also drawn from the plate, but it is wholly doubtful owing to the exostosis in the subtrochanteric region. The value of the pilastric index is that cited by Bumüller and Klaatsch. We do not know its origin, but it agrees reasonably with our 108·7 from the reproduction.

† Values obtained by individual methods and not accurately comparable with other values in this table.

TABLE VIII. *Chief Shaft Section Indices in various Races* (continued).

Race (with oblique length of male femur)	Platymeric Index		Pilastric Index		Popliteal Index		Authorities (data drawn from)
	No.	Magnitude	No.	Magnitude	No.	Magnitude	
Fuegians (426·8)	22	70·1	22	105·1	—	—	Hultkrantz & Rodriguez
Patagonians (462·3) ...	101	74·3	101	110·8	—	—	Rodriguez
South and Equatorial American Indians (415·9)	317	73·5	346	106·6	—	—	Rodriguez & Bumüller
North American Indians (427·2) ...	135	73·4	450	113·7	—	—	Mathews, Workman, Rodriguez, etc.
Eskimos (424·5)	17	80·7	17	109·8	4	77·6	Rodriguez & Hepburn
Laplanders (390·4)	10	78·7	10	107·1	4	70·9	Hepburn & Rodriguez
Canary Islanders (445·8) ...	287	74·7	101	110·2	—	—	Rodriguez
Guanches (447·6)	97	75·9	97	110·9	2	80·4	Rodriguez & Hepburn
Phoenicians and Carthaginians (437·6) ...	16	76·5	16	108·5	—	—	Rodriguez
Neolithic Europeans (444·3)	240	75·1	240	111·1	—	—	Rodriguez
Bronze Age Europeans (431·6)	46	71·5	46	103·7	—	—	
Ancient Slavs (441·7) ...	43	74·7	43	103·6	—	—	
Ancient Etruscans (459·4) ...	—	—	39	105·7	—	—	Sergi
Basques (425·7)	35	79·4	35	104·5	—	—	Rodriguez
Gauls and Romano-Gauls (460·6) ...	78	77·0	78	103·7	—	—	Rodriguez
Franks, Burgundians and Merovingians (451·2) ...	70	77·6	70	105·1	—	—	
Mediaeval French (448·9) ...	183	82·4	183	105·1	—	—	
Modern French (451·3) ...	129	82·6	129	104·8	—	—	Tramond & Rodriguez
Romano-British (447·3) ...	7	67·7	8	98·3	8	73·8	Hepburn
Mediaeval British (Rothwell) (454·5)	290	[79·3]*	291	[106·4]*	—	—	Parsons
17th century Londoners (444·9) ...	855	84·2	867	103·2	826	69·6	Pearson & Bell
"Modern British" (459·0) ...	44	84·6	44	109·4	44	[78·2]	Hepburn
Swabians and Alemanns from Row Graves (464·2)	87	79·7	94	105·3	—	—	Lehmann-Nitsche
Bajuvars from Row Graves (468·0)	30	80·2	182	103·8	—	—	Lehmann-Nitsche
Bavarians (448·2)	410	83·9	415	100·7	53	79·0	Bumüller
Modern Germans (459·4) ...	18	84·4	18	101·9	—	—	Rodriguez
Swiss Alemanns (462·7) ...	235	78·5	244	103·4	—	—	Schwerz
Modern German Swiss (447·1)	30	85·9	30	104·4	—	—	Schwerz & Martin

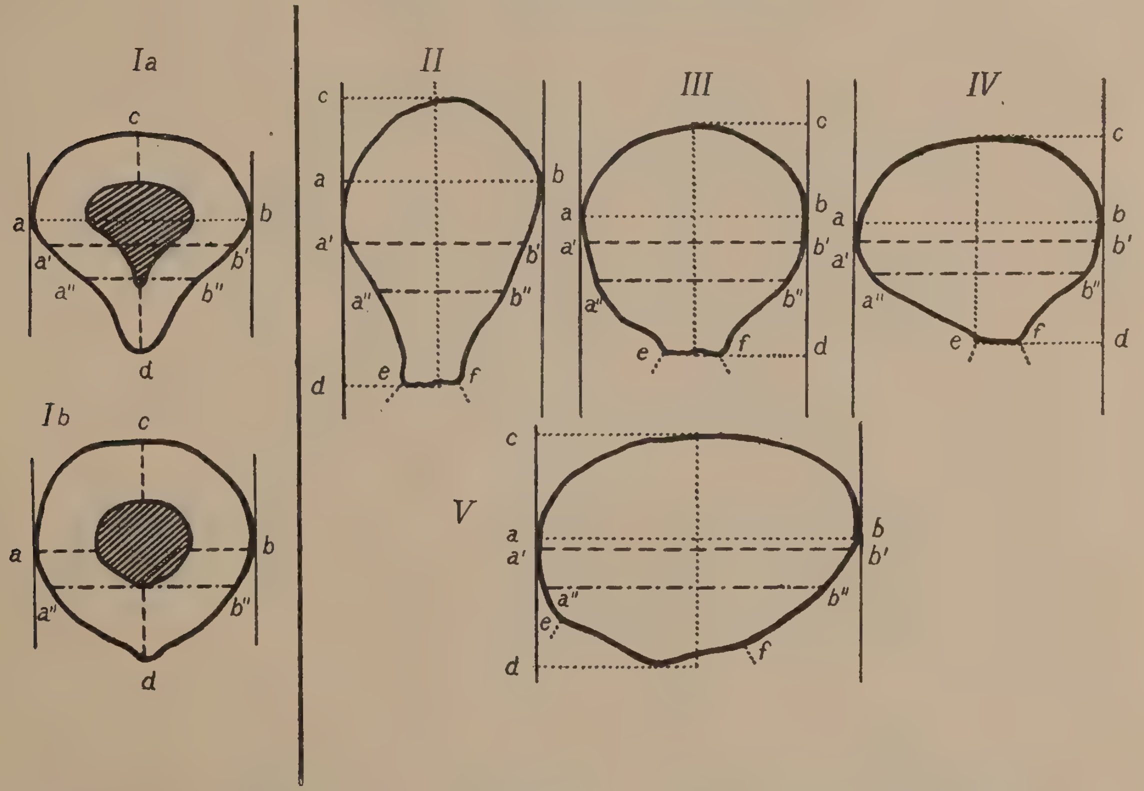
* Values obtained by individual methods and not accurately comparable with other values in this table.

platymery a marked feature of the apes—at least no genus yet investigated has it so intensely as Moriori, Maori or Fuegians.

The popliteal index was at first introduced with a view of settling whether the Trinil femur must be considered human or apelike. The result is unexpected. In the first place the types of early man appear to differ more in popliteal index from the anthropoid apes than modern man does, and, secondly, it may be doubted whether anybody except the owner of the Trinil femur knows what its popliteal index really is!

It will accordingly be recognised that the popliteal or platymeric index in the case of an individual bone is of small service as a criterion of the apelike or the human. The pilastric index is somewhat different, because although the human and ape ranges cross each other no *average* for a human race falls as low as those for the anthropoids. Yet the quadrupedal apes can show averages as high as German or English. Indeed, the tendency in modern as distinguished from primitive races of man seems to be a fall in the pilastric index. The tendency of course has not carried man back to anything like the anthropoid values, but on the whole it appears to exist. The misfortune of the pilastric index is that while it measures the pilaster it measures other things also, and a gibbon with a pilastric index of 100 may merely exhibit a circular cross-section and show nothing of the rounded pear-shape of a human section of like value. What is needed is a better measure of the pilaster than is provided by the pilastric index. In the accompanying diagram two midshaft sections I a and I b are roughly indicated. They have practically the same pilastric index, but the lower one is without a pilaster, while the upper is markedly pilastric. It is clear that the pilastric index is no criterion of the human or apelike characteristics of these two sections.

Pilastric Cross-section of Femur.



Ia and Ib midshaft sections showing the same pilastric index; one with, the other without sensible pilaster. cd = antero-posterior, ab = transverse diameter, $a'b'$ = mid-point breadth, $a''b''$ = third-point breadth, ef = breadth of *linea aspera*. Outlines of Ia and Ib diagrammatic; outlines of II Australian (148), III Shetland (100), IV modern British (85·7), V gorilla (73·0) after Hepburn. II is "pyriform," III is "rotiform" and IV and V "maliform."

Now the essential difference between these is that the maximum transverse diameter *ab* is more nearly central in the non-pilastric than in the pilastric section, and the displacement of the position of the maximum transverse diameter is an essential feature of pilastry. The suggestion which naturally arises is that the pilastric transverse should be taken not as the maximum transverse diameter, wherever it occurs, but either as the mid-breadth of the section, or possibly as the posterior third-point breadth. Another *à priori* interesting character would be the distance of the maximum breadth from the mid-point of the pilastric antero-posterior diameter. We have found, however, that owing to the frequent flatness of the mesial and lateral walls of the bone this distance, and therefore any index based upon it, is not capable of very exact determination. Taking an Australian, a Shetland, a modern British and a gorilla femur given by Hepburn with pilastric indices of 148, 100, 85·7 and 73 we have measured on the drawings he gives of the pilastric sections the mid-point and third-point breadth pilastric indices, and have obtained the following results:

	Maximum Breadth Index	Mid-Point Breadth Index	Third-Point Breadth Index
Australian	148	161 (9 %)	243 (64 %)
Shetland	100	104 (4 %)	115 (15 %)
Modern British	85·7	85·7 (0 %)	95 (11 %)
Gorilla	73·0	73·2 (0·3 %)	81·5 (11 %)

The increases per cent. are given in brackets. Thus with the non- or slight-pilastered femora the increase does not amount to more than 15 per cent., but with the emphatic pilasters to 64 per cent. There is little doubt in our minds that 243, 115, 95 and 81·5 represent much better than 148, 100, 85·7 and 73 the relative importance of the pilaster in these four extreme cases.

Two further pilastric indices also claim our attention:

(i) The *Index of the Linea Aspera.* We take this to be 100 × the breadth *ef* between the lips of *linea aspera* at the pilastric section divided by the antero-posterior diameter of the section. For man this index falls in the twenties. For the anthropoids this index may rise to nearly four times its value in man, *e.g.* to over 80 in the gorilla.

(ii) The *Ellipto-pilastric Index.* Suppose a circle described on the antero-posterior diameter as diameter and let its area be C. Then let A be the area of the pilastric cross-section read with a planimeter. When there is any significant pilaster C is greater than A, that is to say when the section is elliptic with major axis sagittal; when there is absence of pilaster as in the apes the section is elliptic with major axis transverse or C is less than A. We take as ellipto-pilastric index the value $100\,C/A$. Clearly such an index discriminates accurately between cases in which, while the antero-posterior and transverse pilastric diameters are equal, there is and there is not a true pilaster.

For the marked Australian case referred to above the ellipto-pilastric index is 115·7, for the Shetland case 97·7, and for the extreme British case 91·5, which is probably almost a limit on the minimum side for man. For the gorilla section figured by Hepburn it is only 71·6.

The actual determination of the Third-Point Pilastric Index requires a drawing of the cross-section, and that of the Ellipto-pilastric Index a drawing of the cross-section and the use of the planimeter. The two indices can be easily obtained by the use of an instrument devised a number of years ago by one of us, which at the same time draws any contour of a solid body and reads off the area of that contour. The Index of the *Linea Aspera* can be determined at once by any small pair of calipers. We have referred to the matter here because we believe that some explanation is needful of the comparative failure of the pilastric index to discriminate between man and the apes and between the various races of man. It seems to us not the best index that could have been chosen as a criterion. The pilaster is a very real feature with marked variations. A good pilastric index has not to distinguish in the first place between ellipses with major axes in directions at right angles, but between pear-shaped and apple-shaped sections, and this Broca's index fails to do.

We hope later to devote a special study to the comparative value of various pilastric indices. In this memoir we content ourselves with the criticisms which arise almost unbidden from an examination of the preceding table of racial indices (p. 253). No form of anthropometry can be reasonably successful in racial differentiation if the measuremental functions do not adequately express changes in the racial character. It is the racial character which first appeals to the eye, and it is the business of the anthropometrician to be quite certain before he takes into general use any measuremental function that it really does reproduce numerically the phases of the character he desires to discriminate. It is not needful that his function should express every shade in those phases—the character may be multiplex and only some principal factor expressible by aid of the function—but it should at least describe the change of the character in its broad outlines. A measuremental function is inadequate if it can take the same value in an individual which possesses and in one which does not possess the character under discussion, and this can be the case with the so-called pilastric index.

To take this attitude with regard to badly chosen measuremental functions is not to place all statistical work in anthropometry, as Klaatsch did, in a secondary position[1]. Such work is absolutely primary and the only road to safe generalisation. When the statistical and the appreciative methods are placed side by side, the former being based on fitly chosen measuremental functions, there cannot be for a moment a doubt as to which will give the better results—that is evidenced in every case by the ultimate appeal of the appreciative anthropologists to the very statistical methods—generally imperfectly handled—which they started by endeavouring to discredit. They feel their appreciations will carry no weight unless they have statistical support. Even when we have only an imperfect measuremental function, there is no real evidence to show that more knowledge will not flow from it than from the appreciative method unaccompanied by any measurements at all. The comparative, but far from complete failure of cephalic index or pilastric index has not arisen from their being essentially bad, but from their only imperfectly expressing what was originally supposed to be involved in them. The progress of anthropometry will demand more and more complicated measuremental functions rather than a return to those appreciative methods which were so characteristic of the earlier anthropologists and are not without their champions to-day.

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[1] See in particular *Globus*, Vol. 76, p. 355, 1899. Statistics are to be wholly subordinated to the dictates of comparative anatomy, yet the anatomist is not to hesitate in appealing to them, when they do not disprove his prejudgment.

An examination of Table VIII brings out a number of interesting points. Platymery in its extreme forms is not a distinguishing feature of mankind as a whole. It is peculiar to Moriori, Maori, the primitive inhabitants of Japan, the Fuegians and the Polynesians—our "fringe-races"[1]. But the orang-utan is almost as platymeric as the last of these. The Asiatics as a whole fall between the orang and gorilla or chimpanzee, while the most highly civilised races of to-day are only about as platymeric as the gibbon. It is, however, important to note that all the modern European races dealt with seem to indicate that their progenitors were more platymeric than the moderns. This appears to be true of the ancient inhabitants of Europe and the Guanche, Canary, Berber group. The whole of the original inhabitants of America had marked platymery if not so extreme as that of Moriori and Maori. If we attempt to associate platymery with any physical need of primitive races, probably the necessity for speed would occur to many and possibly find confirmation in the recognised speed of the American Indians. But it would be difficult to separate the non-agile orang from other anthropoids on this ground. Any explanation must probably be sought first in the correlation between platymery and other features of the femur—a point to which we shall return. It is clear that the "scission of the primates," if not wholly of the same character, is involved in platymery as in pilastry.

In the pilastric index it is again not the most civilised races which exhibit most pilaster, as judged by the pilastric index. It is the Asiatic and Australasian groups which are most pilastric, the American Indian group follows, and the modern Europeans show probably the lowest general pilastric index, possibly but not certainly lower than the early and prehistoric Europeans[2]. The modern Japanese are lower than the earlier inhabitants of Japan while the latter like the European neolithic group approach the Guanche-Canary and Negroid groups. If we can trust the small numbers of the Neanderthal and Spy cases, there was marked difference between them and the Cromagnon type. The modern European differs from the neolithic European almost as the Cromagnon from the Neanderthal type. While pilastric and popliteal indices give the like order for the anthropoids, at present the orang-utan stands out of place in platymery. Possibly some change may be made when a larger number of orang femora have been measured. But notwithstanding the gorilla femur is furthest and the gibbon femur nearest in the values of these indices to Neanderthal man. It is such a resemblance, however far removed, which in part has led Bumüller to speak of the

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[1] A similar link between Maori, Moriori, Fuegian and Aino has been pointed out with regard to features of their crania: see *Biometrika*, Vol. XI, pp. 101 *et seq.*

[2] Probably no stress can be laid on the small Romano-British group or Hepburn's very heterogeneous series of modern British. Parsons' result which should have been useful is not comparable. Thus it is hard to determine any direction of change in the British group. The French group shows little change, but the Germans a considerable fall. Modern European races are less pilastric than neolithic European races.

Trinil femur as that of a giant gibbon! Before much stress can be laid on such slight correspondence of indices as exists those for *Pithecanthropus erectus* must be far more accurately determined than they are at present.

In the popliteal index there is a fairly continuous rise from the gorilla to early man broken, however, by the positions of *Cebidae* and *Simiadae* with regard to the anthropoids. Here, as in the pilastric index, the *Simiadae* stand between the gibbon and man. Unfortunately our popliteal indices are few and the data on which they are based very scant. But it seems probable that while some few primitive races—Maori, Lapps and Andamans—have an almost apelike value of the popliteal index, others like the Australians, Negroes and the Neanderthal type have a high one. We have not enough races of modern man measured to be dogmatic, but it would appear that, as in the case of the platymeric index, the English at least and possibly the Germans have receded to the more apelike form of the popliteal section[1]. It must be remembered that the popliteal index was originally introduced as a means of analysing at least partially the nature of the popliteal area. This it is only partially successful in doing. The ape has a low popliteal index but its popliteal area as a rule is convex. In the case of man, however, the concave femora as a rule have a low popliteal index but the convex femora have a high index. The exaggerated popliteal transverse in the apes more than compensates for the increased antero-posterior diameter due to the convexity. Thus in modern man the low popliteal index may be due to increased concavity, while the high popliteal index in the Australian may be due to convexity associated with a transverse diameter much reduced on that of the ape. Had a true measuremental function of the curvature of the popliteal surface been taken—say, subtense by chord at posterior boundary of popliteal section[2]—we should probably have found an evolutionary order: ape, Australian, modern European, instead of the popliteal index order: ape, modern European, Australian. We have thus another instance of an imperfect measuremental function arising from a non-adequate geometrical appreciation rather than from a real defect in statistical method. It is easy to demonstrate the truth of this view. We have for mean values from Hepburn's data:

No.	Race	Popliteal Transverse	Popliteal Antero-Posterior
15	Maori	37·76	28·60
14	Andaman (I)	28·92	22·21
12	Andaman (II)	37·24	28·60
14	Australian	33·57	28·64

Andaman (I) denotes actual Andaman values. Andaman (II) denotes actual values magnified so that the smaller Andaman has the same antero-posterior diameter as the bigger Maori; he has now also the same transverse diameter. The Australian had the same antero-posterior diameter to start with; but we see that his popliteal transverse is much shorter. His high popliteal index is simply due to this diminution of popliteal transverse, and not to an increased antero-posterior diameter, the result of greater convexity. The popliteal index is thus only an imperfect measure which does not properly discriminate between two fundamental factors, concavity of area and ellipticity of section.

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[1] A noteworthy position is occupied by the Galley Hill femur in regard to all three indices—it provides values which hardly smack of modernity.

[2] This index would have been positive for the apes on the average, probably about zero for the Australian and Neanderthal man and actually negative for modern man. Our own Australian femora fall into the "flat" category.

At the same time, if we allow that these shaft indices determine ellipticity rather than the extent of pilaster or of convexity in the popliteal area, it is not without interest to determine to what extent the general ellipticity of the subtrochanteric region is or is not associated with those of the midshaft and popliteal regions. This problem in a restricted sense has been a good deal discussed, but by rather inadequate methods. Attention was first drawn to it by Manouvrier, who considered whether increase in platymery was associated with a change in the pilastric index. Kroutowski in 1892[1] dealing with neolithic femora from Châlons-sur-Marne and Mareuil-les-Meaux gave the following slender data :

	No. of Femora	Platymeric Index	Pilastric Index
1st Group	4	90·4	118
2nd Group	5	77·6	105

According to this a high platymeric index is associated with a high pilastric index or accentuated platymery with an absence of pilastry. Manouvrier in the following year[2] dealt with a small collection of femora from Andresy of the Merovingian epoch and gives the following results :

	No. of Femora	Platymery	Pilastric Index
1st Group	17	None	110·3
2nd Group	18	Feeble	104·0
3rd Group	19	Accentuated	100·5

As far as these go they confirm Kroutowski. But the method and total frequency is inadequate, and the classification of platymery unsatisfactory.

Still a further table of the same character is given by Manouvrier and Antony[3] for the neolithic femora from Montigny-Esbly.

	No. of Femora	Platymeric Index	Pilastric Index
1st Group	15	80·1	120·5
2nd Group	17	79·7	111·8
3rd Group	18	76·2	105·1
4th Group	13	74·1	98·9

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[1] Bibl. 54, p. 483.

[2] Bibl. 57. See also "Étude des ossements humains de l'époque mérovingienne trouvés à Andresy." *Association française. Congrès de* 1890.

[3] Bibl. 96.

Here again the method of selection to get means of groups is not clear, and considering the variation in both indices, the correlation method used is inadequate, and almost any series of results might be deduced by various processes of selecting groups. Still all these results confirm the view that both indices increase and decrease together. Some confusion, however, was introduced into this more or less accurate result by Manouvrier's use of the term "transverse platymery" for extreme cases of what we should now term stenomery. The reader who will examine our correlation tables for the platymeric and pilastric indices will not, however, find that there is anything special in the bulk of stenomeric cases; they are associated, as we should expect them to be, with the higher pilastric values, and they do not correspond to the same association as the sagittal platymery which is found with the lower pilastric values. Bumüller[1] also gives a somewhat crude correlation table:

Pilastric Index

Platymeric Index	(I) Up to 90 (exclusive)	(II) 90—100	(III) 100—110	(IV) Over 110	(V) Under 100 + Pilaster	Totals
Up to 100	0	1	22	24	1	48
99·9—85	11	15	62	33	8	129
84·9—80	12	14	30	9	8	73
Under 80	28	26	47	9	44	154
Totals	51	56	161	75	61	404

It is very difficult to do anything with this table, partly owing to the largeness of the groupings, partly because the subranges are not equal ("up to" and "over" give no proper subranges, and where is the pilastric index 100 put?), and partly because of the anomalous Group V, "under 100 with pilaster." The existence of such a group only shows the inadequacy of the pilastric index as a measure of the pilaster. To obtain a rough measure of the correlation we have divided Group V between Groups I and II, and then formed a tetrachoric table as follows:

Pilastric Index

	Up to 100	Over 100	Totals
Up to 85	132	95	227
Over 85	36	141	177
Totals	168	236	404

The tetrachoric coefficient = +·58. Thus we see that Bumüller's data confirm Manouvrier's statement that high platymeric indices are associated with high pilastry, and considering the roughness of the table and the two grave divergences between his methods and ours[2] the correlation value is not numerically so very far from those of our correlations on the following page.

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[1] Bibl. 81, S. 47.

[2] Bumüller includes the gluteal ridge in his platymeric antero-posterior diameter and he avoids the place where the pilastric antero-posterior diameter is a maximum.

Bumüller while himself quantitatively reaching the same result as Manouvrier, *i.e.* increase of platymeric index (*not* be it noted of platymery) with increase of pilastric index, appears to criticise all results reached by Manouvrier in the matter[1]. Klaatsch, after referring to Manouvrier, Boncour and Bumüller, holds that a relation exists between pilastry and platymery, but that its nature has not yet been cleared up. We have no hesitation in saying that there is very considerable correlation of a positive sense between platymeric and pilastric indices. Our tables are given below, pp. 272 *et seq.*, and our correlations taken from Table II of Chapter VI, p. 194, are:

♂ R.	♂ L.	♀ R.	♀ L.
+ ·551 ± ·031,	+ ·455 ± ·034,	+ ·388 ± ·043,	+ ·405 ± 041.

To compare with these values we may take a table prepared by Schwerz[2], wherein the permilles of each pilastric and platymeric index are given for the Alemanns of Switzerland. Unfortunately his table sums to 970 instead of 1000, and there must be an error somewhere. He speaks of using 430 femora, but if the numbers in his table be multiplied by ·43, they sum to 418 and not 430. The table given below then results, which is the most consistent correlation table we can reconstruct out of Schwerz's data. It leads to the values:

Platymeric Index

Pilastric Index	Up to 64	65—69	70—74	75—79	80—84	85—89	90—94	95 and over	Totals
Up to 89	4	4	2	1	1	1	—	—	13
90—94	1	5	15	6	2	1	—	—	30
95—99	1	3	1	9	7	3	2	—	26
100—104	2	9	28	42	35	21	8	1	146
105—109	2	1	12	14	19	10	7	1	66
110—114	1	3	11	10	16	13	13	4	71
115—119	—	1	5	5	7	3	9	4	34
120 and over	—	1	1	2	6	13	4	5	32
Totals	11	27	75	89	93	65	43	15	418

	Mean	Standard Deviation	Correlation
Pilastric Index ...	105·74	7·10	+ ·629 ± ·020
Platymeric Index	79·97	6·73	

This compares fairly well with the + ·58 for the Bavarians. If we were to take the mean value of our four coefficients directly weighting with their frequencies, it would be + ·456. Are we then to conclude that there is a somewhat higher relationship between the indices of the Germanic group than between those of our London group? We cannot think this demonstrated, and for three reasons: (i) Bumüller's methods differ in important points from ours, and clearly in measuring the pilastric index Schwerz had some prejudice in favour of the decades, which might well emphasise the correlation. (ii) Both the tables we have deduced from Bumüller and

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[1] Bibl. 81, S. 47—48.

[2] Bibl. 107, S. 655.

Schwerz's data are to some extent guesswork, as their material is not given in a form from which such tables can be accurately deduced, and lastly, (iii) they have combined right and left sides and both sexes.

Now our values are

	♂ R.	♂ L.	♀ R.	♀ L.
Pilastric Index Mean ...	105·81 ± ·42	103·13 ± ·38	103·85 ± ·46	99·48 ± ·46
" " S. D. ...	9·532 ± ·295	9·262 ± ·279	9·166 ± ·321	9·423 ± ·322
Platymeric Index Mean	85·33 ± ·39	85·11 ± ·40	84·08 ± ·48	81·75 ± ·40
" " S. D. ...	8·765 ± ·272	9·347 ± ·284	9·606 ± ·342	8·194 ± ·281
Correlation	+ ·551 ± ·031	+ ·455 ± ·034	+ ·388 ± ·043	+ ·405 ± ·041
Numbers	236	247	179	192

The probable errors show that both pilastric and platymeric indices are differentiated with side and sex[1]. Thus combination of sex and side will increase spuriously the correlation. If we combine[2] our material for both sides and sexes, we find the resultant correlation to be + ·510 or an increase of 12 per cent. beyond the weighted mean value of + ·456. Something therefore of the excess in the Alemann and Bavarian correlations is due to this pooling, as well as to the other differences referred to above.

It seems safe to say that *within any individual race*, the correlation of the elliptic tendency in platymeric and pilastric sections is of the order + ·5. We now ask what relations these indices bear to the popliteal index and find them positively, significantly but less substantially correlated with it. Our values are

	♂ R.	♂ L.	♀ R.	♀ L.
Platymeric Index and Popliteal Index ...	+ ·113 ± ·044	+ ·109 ± ·044	+ ·130 ± ·050	+ ·099 ± ·049
Pilastric Index and Popliteal Index ...	+ ·278 ± ·041	+ ·221 ± ·042	+ ·256 ± ·047	+ ·149 ± ·048

We have unfortunately no comparable data, but the above correlations seem sufficient to indicate that the three sections of the shaft tend generally in the same sense, two sections being more alike if they are adjacent. It appears to us that this general tendency of the various sections of the shaft to be apple-shaped, rotund or pear-shaped, rather than the moulding of the sections by *M. glutaeus*, *M. cruralis* or *M. vastus internus*, is the keynote to the relations between the platymeric, pilastric and popliteal indices. According as the pilastric section is like the typical human pilastric—pear-shaped, like the typical gibbon pilastric—rotund, or like the typical gorilloid pilastric—apple-shaped, we may call the shaft pyriform, rotiform or maliform. In numbers we might take pyriform pilastric sections those with index exceeding 102, the maliform those with index under 98, and those between 98 and 102 can be considered rotiform. Primitive races and early man are pyriform on the whole, the anthropoids are maliform, while the Cercopithecidae and the lemurs are rotiform. Modern man is moderately pyriform, with a tendency to the rotiform, which appears to have been already reached by the modern German[1].

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[1] Schwerz does not separate sides, but he gives: Pilastric Index ♂ 106·7, ♀ 103·4 and Platymeric Index ♂ 80·5, ♀ 78·5; thus confirming our conclusion that both indices are higher in male bones.

[2] See Pearson, *Phil. Trans.* Vol. 192 A, p. 277.

When we say that there is a correlation in form between the pilastric and the platymeric or popliteal surfaces we of course do not mean that they are always pyriform or even rotiform when the pilastric section takes these characters. All we understand is that the indices of these two sections will move in sympathy with the index of the pilastric section in the direction of rotundity and pyriformity. For example, we have in our series seven male femora with pilastric indices between 125 and 129, their platymeric indices fall into the groups 91—93 (1), 94—96 (2), 97—98 (1), 100—102 (1), 103—105 (1), 112—114 (1). Thus all are much in excess of the mean male index of 85, and two are actually rotiform and two pyriform.

We ourselves look upon the shaft as a whole and its character whether pyriform, rotiform or maliform as hereditary. Particular types may have been selected because they gave for a special environment or habit a better insertion area for one or other muscle, but the selection of a particular form of subtrochanteric, midshaft or popliteal region would in itself modify the correlated regions[2].

An important question with regard to the correlation of the shaft sections which we have indicated as existing *intraracially* arises when we consider the problem *interracially*[3]. Is there a correlation between the racial mean or type values of the shaft indices?

To answer this question we have only our data in Table VIII. Excluding the apes we have 44 races with platymeric and pilastric indices and 14 with popliteal indices as well. The three interracial correlations are:

Pilastric and Platymeric:	− ·0406
Pilastric and Popliteal:	+ ·2502
Platymeric and Popliteal:	+ ·1624

The results seem very remarkable.

The interracial correlations for popliteal index with both pilastric and platymeric indices do not sensibly differ from the intraracial values; indeed they are surprisingly close, considering the largeness of error due to paucity of data. The popliteal index is still somewhat more closely related to the pilastric than to the platymeric. But

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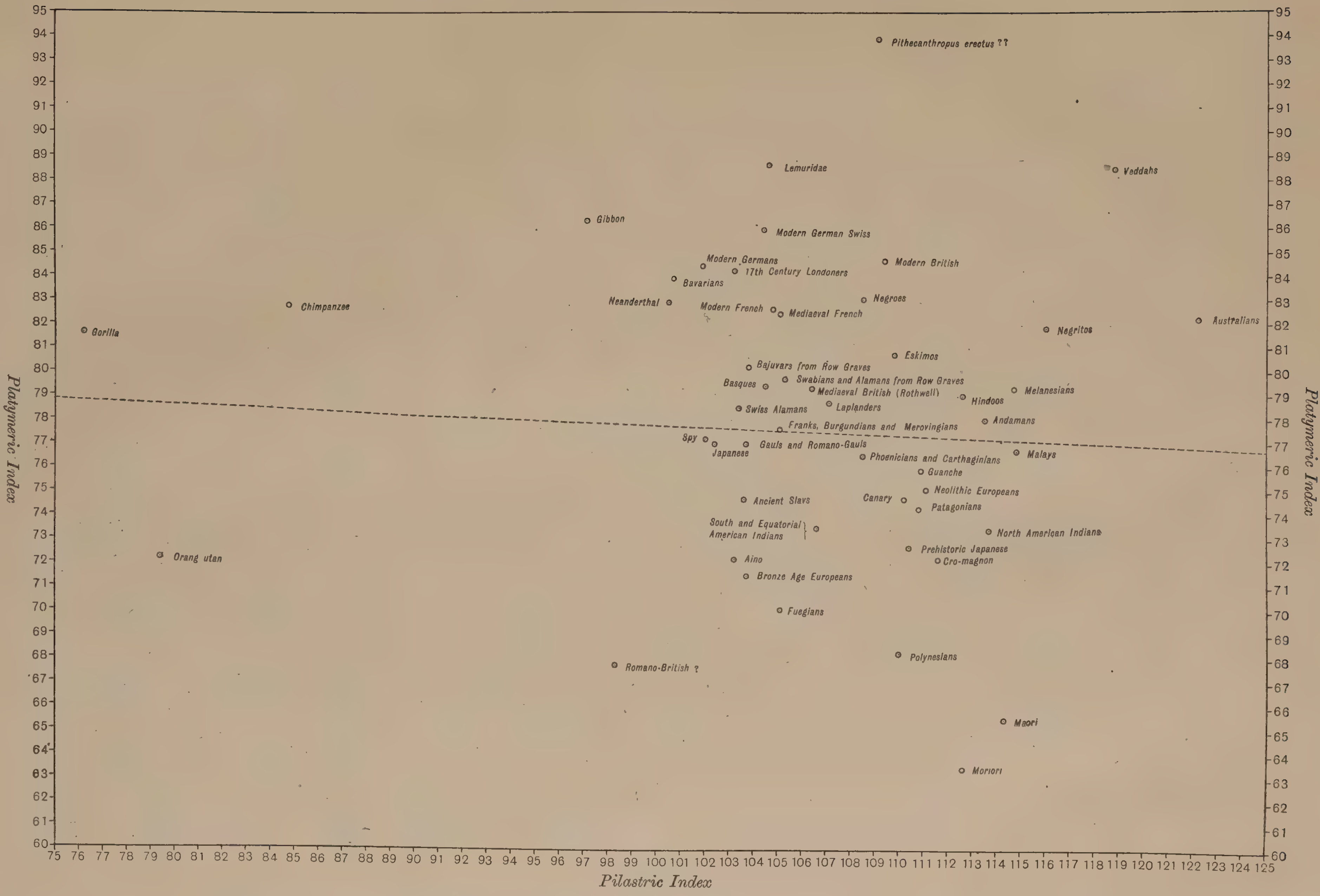
[1] The Neanderthal-Spy type was rotiform, the Cromagnon type was pyriform; it is possible that this distinction has been maintained in our Londoners and the French as compared with the Germans, but this comparison would not hold for the platymeric indices of these races.

[2] We object just as much to Manouvrier's view of "la saillie pilastrique comme la platymerie produite sous l'influence du muscle crural" or of a portion of the crural muscle altering its "action modificatrice sur le fémur, suivant la nature des occupations et du genre de vie des différents individus" (Bibl. 57, p. 131) as we do to his critic Bumüller's statement that: "die Stenomerie wird durch den Muskeldruck des cruralis hervorgerufen," or that the convexity of the anterior surface can be explained owing to the compression exercised by the muscle, which squeezes the diaphysis in the direction of its transverse diameter (Bibl. 81, S. 53).

[3] For the first introduction of the conceptions involved in intraracial and interracial correlations see *Biometrika*, Vol. I, p. 460.

Racial Correlation of Pilastric and Platymeric Indices.



The broken line is the regression line of Platymeric Index on Pilastric Index for the human portion of the data only.

the interracial value of the correlation between pilastric and platymeric indices is not only reduced to insignificance, but is opposite in sign to the intraracial correlation. We know of such differences between interracial and intraracial in other cases[1], but they are always of marked interest as bearing on the differential selection of race characters by environment and by habits of life necessary to fit that environment. As an interracial character platymery (low index) is just possibly associated with pilastry (high index), while the reverse holds in a high degree inside the race. If we might hazard a suggestion we should incline to believe that both subtrochanteric and mid-shaft regions had been stringently and diversely selected in the modified conditions of the struggle for existence in different parts of the world; but that the popliteal region had been much less stringently selected and had followed in correlated change the changes in the higher regions of the shaft.

The interracial correlationship is exhibited as a "spot diagram" in the chart on the previous page. The regression line obtained is based only on the human elements; it is, perhaps, suggestive that it passes to the centre of the anthropoid apes rather than towards any of the primitive races; these appear more or less as outliers of the main human group rather than as links in a chain of descent from an apelike form to civilised man.

A further interesting point, since the pilaster is peculiar to the upright primate, is the question of how far it is correlated with stature. Now the only measurement we have suggestive of stature in this case, and it is by no means a bad one[2], is that deduced from length of femur. Hence the relation of length of femur to the indices of the cross-sections of the shaft is of some interest. An examination of the BS section of Table II, p. 194, shows that the correlation of platymeric index and maximum length of femur is slight and irregular in sign except in the case of the female left bone where it appears to be significant but small. On the other hand the correlations of pilastric index with maximum length of femur are uniformly positive and two at least are certainly significant. As we can from our data[3] obtain further the correlations of length of shaft with pilastric index we place both series of correlations here for comparison:

Pilastric Index with	♂ R.	♂ L.	♀ R.	♀ L.
Maximum Length of Femur ...	+ ·102 ± ·045	+ ·204 ± ·043	+ ·121 ± ·051	+ ·282 ± ·047
Length of Shaft	+ ·059 ± ·043	+ ·239 ± ·043	+ ·111 ± ·051	+ ·317 ± ·050

Now these results seem of considerable interest. They show (i) that there is no marked relationship between the pilastric index and either length of femur or length of shaft, (ii) that there are distinct differences in the correlation between left and right sides, and (iii) probably distinct differences between male and female, the latter being for the same bone in every case more highly correlated. These latter results confirm what we have already stated, *i.e.* that spurious results may be reached by pooling indices for both sexes and both sides.

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[1] See for cranial lengths *Biometrika*, Vol. II, p. 355, and for nasal heights, *Biometrika*, Vol. IX, p. 423.

[2] See Bibl. 79 for correlation of femoral length and stature and our p. 5.

[3] Let S = length of shaft, d_1 = antero-posterior, d_2 = transverse diameter, r = correlation, and V = coefficient of variation, while $i = 100d_1/d_2$; then $r_{si} = (V_{d_1} r_{sd_1} - V_{d_2} r_{sd_2})/V_i$. Both r_{sd_1} and r_{sd_2} are given in section SS of Table II, p. 195, V_{d_1} and V_{d_2} in Table III of p. 164 and V_i in Table IV, p. 165.

The first result seems to indicate that neither long femur nor long shaft in themselves produce a marked pilaster, *i.e.* if there be a mechanical influence, such as certain writers have suggested, it is of secondary importance.

More substantial correlations are obtained by correlating the absolute length of the pilastric antero-posterior diameter with the length of shaft[1], *i.e.*

♂ R. + ·263 ± ·042, ♂ L. + ·399 ± ·038, ♀ R. + ·246 ± ·049, ♀ L. + ·459 ± ·040,

but it is difficult to argue more from this than that general increase of size of femur increases both length of shaft and pilastric antero-posterior diameter. At the same time the correlations are distinctly larger between the shaft length and the antero-posterior diameter than between the former and the transverse diameter:

$\left.\begin{array}{l}\text{Length of Shaft}\\ \text{and Transverse}\\ \text{Diameter}\end{array}\right\}$ ♂ R. + ·193 ± ·043, ♂ L. + ·164 ± ·043, ♀ R. + ·121 ± ·051, ♀ L. + ·108 ± ·050.

On the whole we may conclude that there is some relation between size of femur and the pilastric index and that this is more marked in the influence of size of femur on the antero-posterior than on the transverse diameter. But the influence is not of such intensity that it justifies us in assuming that size of bone or indeed the stature largely influences the development of the pilaster *mechanically*.

If the big individual has on the whole a somewhat higher pilastric index, we may ask if this relationship is maintained when we consider the matter interracially. Have the taller human races more pyriform femora? We have the pilastric and platymeric indices for a number of races in our Table VIII, p. 253. Unfortunately, as we have seen, the bulk of investigators have pooled their data for both sexes, and we are ignorant of the proportions in which they are mixed. Further not all investigators have given the same absolute length of the femur. On examination it appeared that the oblique length was more commonly given. We have accordingly taken as a reasonable indication of the stature of a race the *oblique* length of the *male* femur, and modified the maximum length, when that only has been provided. Our figures are thus only approximate, but amply sufficient to indicate whether there is any close relation between the stature of a race and its platymeric or pilastric mean index.

We find for 44 races:

$\left.\begin{array}{l}\text{Interracially, correlation of oblique length of male femur}\\ \quad\text{and platymeric index}\end{array}\right\}+\cdot064.$

$\left.\begin{array}{l}\text{Intraracially for our Londoners' mean platymeric index and}\\ \quad\textit{maximum}\text{ length of femur correlation}\end{array}\right\}+\cdot057.$

There is thus possibly a very small positive correlation between length of femur and platymeric index, and this may be taken to be the same intraracially and interracially. Thus the platymeric races are the slightly shorter races, but the association of platymery with stature is of the slightest. Turning to the pilastric index we have:

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[1] It will be seen that the pilastric antero-posterior diameter has like the index increased correlations in the *left* member.

Interracially, correlation of oblique length of male femur and pilastric index } −·114.
Intraracially for our Londoners' mean pilastric index and maximum length of femur correlation } +·177.

Neither of these correlations is very substantial, but there is a great difference between them. Within the race excess of stature is associated with a more marked pilaster, but the short race on the average has more pilaster than the tall race. This interpretation seems borne out by the fact that short races like the Veddahs, Andamans, Negritos have high pilastric indices. But the rule is only an average rule and the correlation is so low that exceptions like the Australians and Patagonians of course occur. The tall modern civilised races are, however, approaching the rotiform femur. It would thus seem that the evolutionary explanation of pilastry must not be sought to any large extent in the need for increased strength to carry the vertical weight imposed on the femur, but may possibly have to be associated with agility in the vertical position whether it be in speed of running, or managing a canoe, etc.

Turning next to the question of the influence of growth on the fundamental indices of the shaft we divided our non-adult 42 femora into three groups: (i) Femora with diaphysial length from 15 to 25 cms.—there were 12 of these with a mean diaphysial length of 21·51 cms. (ii) Femora with diaphysial length greater than 25 cms., but which were not capable, owing to absence of epiphyses, of having neck or maximum length determined. The mean diaphysial length of 13 such femora was 31·2 cms. (iii) Cases in which the neck was capable of measurement but maximum length was impossible (9 cases with mean diaphysial length 37·2) and cases in which the epiphyses were present, but the sutures still open (8 cases reaching up to the mean adult diaphysial length of 38 to 39 cms.). The diaphysial length is here taken from epiphysial border to epiphysial border.

Influence of Age on Fundamental Indices of Shaft[1].

Age Group ♂ + ♀	Platymeric Index	Pilastric Index	Popliteal Index
Epiphyses lacking, Diaphysial Length 25 cms. and under	88·0 [± 1·7]	107·2 [± 1·8]	69·6 [± 1·2]
Epiphyses lacking, Diaphysial Length over 25 cms.	87·4 [± 1·7]	112·1 [± 1·7]	69·9 [± 1·1]
Epiphyses imperfect but neck form with epiphyses formed	84·5 [± 1·5]	106·0 [± 1·5]	72·0 [± 1·0]
Adults (826 to 867)	84·5 [± 0·2]	103·2 [± 0·2]	69·6 [± 0·1]

The probable errors warn us to be careful of laying any great stress on these results. The suggestions which arise are: The platymeric index decreases or platymery increases with age. Pilastry decreases with age; it appears to rise from infancy

[1] Probable errors roughly approximative.

to childhood and then to fall steadily in the adult. It is venturesome to assert anything of the popliteal index, but this like the pilastric *appears* if we could trust the differences to increase with age and then again decrease. To sum up: the shaft of the femur seems to have its minimum of flatness at all three fundamental sections in the adult stage, although its maximum rotundity may be reached in infancy (platymeric index), in childhood (pilastric index), or on approaching the adult stage (popliteal index). In the case of pilastry "maximum rotundity" must be interpreted to mean sagittal oblateness.

The only comparative material I have found is the following:

Bumüller[1] gives some slender data for embryos and children up to 7th—8th year:

Age Group	Platymeric Index	Pilastric Index	Popliteal Index
Diaphysial Length 3 to 8 cms., Mean 6·4 (8 cases)	81·9	98·6	65·5
Diaphysial Length 18·5 to 25·5 cms. Mean 22·2 (5 cases)	83·5	108·2	60·5
Adults (circa 400 cases)	83·9	100·7	68·2

For the pilastric index he obtains a maximum in childhood and a fall to the adult stage, but his other results are not in accordance with our somewhat more ample material. He finds a minimum with childhood in the popliteal index and an increase with age in the platymeric index; the very reverse of our results. But as he includes the gluteal ridge in his platymeric antero-posterior diameter, difference of method may be as influential as the smallness of both our samples. There is but little hope of full light on the manner in which the sections of the shaft change during growth until the material can be increased 10- or 20-fold[2].

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[1] Bibl. 81, pp. 85—87.

[2] Rodriguez (Bibl. 101, p. 48) has a very brief sentence in his section "Variations suivant l'âge" (the whole a page in length with no numerical values); he says: "*Les indices pilastrique et platymérique* sont plus élevés chez les jeunes." He had 52 femora non-adult of all kinds of races and he does not say that he has divided them into age groups. Bertaux (Bibl. 52, pp. 210—220) has a number of young (child) femora for which he does not give any pilastric or platymeric indices. On p. 220 he has a table giving means according to age and the entries:

Mean according to Age.

	Under 20	20 to 40	40 to 60	Over 60
Length	374·0	432·4	439·0	429·6
Pilastric Index ...	113·0	102·8	104·7	102·1

But on examining his data pp. 212—215, the first group under 20 appears to consist of the right and left femur of *one* individual (male) aged 18, and therefore we think no statement can be made that this index decreases with age.

Note I. to Broca's Table (see p. 252).

The following table gives a somewhat wider range than Broca's of the pilastric index in various living forms. In drawing up this table we had hoped that we could take the needful measurements from Dr J. S. Foote's paper, "A Contribution to the Comparative Histology of the Femur[1]," which has at first sight an apparent wealth of information on the midshaft section of the femur in many living forms. The work is edited by Dr A. Hrdlička, and bears the *imprimatur* of Dr Frank Baker, Dr G. A. Piersol and Dr A. Hrdlička himself. But as often as not the sections on the plates (of which no scale is provided) do not agree even relatively with the measurements in the text. In a large number of femora with which we have some familiarity the wrong orientation is given in the plates. In a good many cases the section is cut through the third trochanter without comment, and sometimes the third trochanter may be so orientated as to appear as a pilaster! We might suppose this due to convenience in placing on the plate were it not for the fact that the antero-posterior and transverse (here called lateral) diameters are interchanged in the text itself. This interchange has taken place with regard to a very considerable number of femora we knew well previously or have examined since our suspicions were aroused by the perusal of Dr Foote's memoir. We feel fairly certain of having in the case of the Mammalia discarded the bulk of these erroneous cases, replacing them by larger numbers measured by ourselves. The case is different, however, with the Bats, Amphibians and Reptiles; we are not convinced that the frequent errors found in the field with which we are more familiar may not exist in these groups. Our results therefore for these groups are based merely on Dr Foote's data and cannot be considered final. For Birds we have been able to some extent to check Dr Foote's measurements by measuring 21 avian femora in our own possession. For Man we think it safe to use Dr Foote's data, and they add some interesting material to our series of racial values.

Table IX. *The Pilastric Index in Living Forms.*

White Fetus (up to 9 months) (6)	115·3	Man (Foote). Compare: Man (Chief Races of the World) 109·9 (Present Authors) Man (17th century Londoners) 103·02 (Present Authors)
American Indians (Children) (3)	109·1	
American Negroes (25)	109·7	
American Indians (Adults) (19)	102·2	
American Whites (Adults) (68)	101·8	
12th Dynasty Egyptians (7) ...	101·3	

Primates (other than Man).

Anthropoids (19) ...	85·0	(Broca and Foote)
„ (187) ...	83·8	(Present Memoir)
Cebidae and Simiadae (45)	101·1	(Broca and Foote)
„ „ „ (86)	98·3	(Present Authors)
Lemuroids (42)	100·6	(Present Authors)

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[1] *Smithsonian Contributions to Knowledge*, Vol. xxxv, No. 3, pp. 1—231, Washington, 1916.

Amphibians (39)	116·3 (Foote)	Birds (omitting Struthionidae) (37)	104·0 (Foote)
Reptiles (omitting Turtles) (26)	124·3 (Foote)	Birds („ „) (21)	111·3 (Pearson)
Turtles (8)	96·5 (Foote)	Struthionidae (3)	124·9 (Foote)

MAMMALIA (Present Authors + Foote).

Carnivora.	Carnivora vera (61)	93·5	Rodentia.	Simplici dentali (23)	81·9
„	Pinnipedia (1)	50·0		Duplici dentali (2)	75·9
Ungulata.	Artiodactyla, Pecora (26)	110·8	Insectivora.	Insectivora vera (10)	78·5
„	„ Tragulina (1)	107·1		Dermatoptera (1)	118·2
„	„ Tylopoda (2)	101·0	Chiroptera (55) (Foote only)		114·3
„	„ Suina (4)	112·1	Edentata (15)		69·8
„	Perissodactyla (8)	124·3	Marsupialia (6)		96·6
„	Hyracoidea (2)	91·3	Monotremata.	Echidnidae (2)	47·7
„	Proboscidea (3)	140·2	„	Ornithorhynchidae (2)	70·0

The main feature of a table like the present is the evidence that it provides of man's unique position in pilastric index. The other anthropoids do not approach him. We have to ascend to the Old World monkeys and the Lemuroids to reach a mean pilastric index over 100, and then the source of this value is not usually the same as that of the still higher index in Man. It arises from a rotiform not a pyriform pilastric section. Even when we get, as in the Birds or Pecora, an index as high or higher than in Man, the source lies in a rotiform section being extended antero-posteriorly to an elliptic section, and not in the development of the characteristically human pyriform section. To find traces of this we must search among the lesser apes and anthropoids, and the traces are not very marked then. Indeed, the rotiform section is still by no means a scarce variety in Recent Man, and in almost any long series of femora we can mark both rotiform and pyriform pilastric sections. The pyriform section, we have suggested, came in fairly rapidly with Cromagnon Man; the present mixture is hardly explicable without postulating a fairly recent ancestor with a roughly rotiform pilastric section—a direct descent from or at least a hybridisation by a Neanderthal type.

Any interpretation, however, of such a table as the present which does not distinguish between 110 in Man and in Pecora is foredoomed to failure. The high pilastric index of Man screens an almost unique development from the anthropoid stem; the high value in Pecora is most probably a vestige of a much earlier living form.

NOTE II. Correlations of Platymeric, Pilastric and Popliteal Indices having regard to Side and Sex. For reference see p. 262. We place here the tables on which these correlations are based.

(i) *Platymeric Index.* ♂ R.

Pilastric Index	63·5– 66·5	66·5– 69·5	69·5– 72·5	72·5– 75·5	75·5– 78·5	78·5– 81·5	81·5– 84·5	84·5– 87·5	87·5– 90·5	90·5– 93·5	93·5– 96·5	96·5– 99·5	99·5–102·5	102·5–105·5	105·5–108·5	108·5–111·5	111·5–114·5	114·5–117·5	Totals
74·5– 79·5	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
79·5– 84·5	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	2
84·5– 89·5	—	2	—	3	—	1	—	1	—	—	—	—	—	—	—	—	—	—	7
89·5– 94·5	1	—	4	4	3	4	2	2·5	·5	—	—	—	—	—	—	—	—	—	21
94·5– 99·5	—	—	1	2	5	5	7	2	1	1	—	—	—	—	—	—	—	—	24
99·5–104·5	—	—	1	3	7	8	9	7	3	4·5	1·5	1	2	—	—	—	—	—	47
104·5–109·5	1	—	—	2	4	5	8	12·5	4·5	4	2	3	3	1	—	—	—	—	50
109·5–114·5	—	—	1	3	1·5	3	5	4·5	6	8	2	4	2·5	1	1	—	—	—	42·5
114·5–119·5	—	—	—	1	1·5	1	2·5	5	6	4	2	1	5·5	—	—	—	—	—	29·5
119·5–124·5	—	—	—	—	—	—	1	2	1	1	1	—	—	—	1	—	—	—	7
124·5–129·5	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	1	—	3
129·5–134·5	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1
134·5–139·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
139·5–144·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
144·5–149·5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
Totals ...	2	2	9	18	22	27	34·5	37·5	23	23·5	9·5	9	13	2	2	0	1	1	236

(ii) *Platymeric Index.* ♂ L.

Pilastric Index	66·5– 69·5	69·5– 72·5	72·5– 75·5	75·5– 78·5	78·5– 81·5	81·5– 84·5	84·5– 87·5	87·5– 90·5	90·5– 93·5	93·5– 96·5	96·5– 99·5	99·5–102·5	102·5–105·5	105·5–108·5	108·5–111·5	111·5–114·5	Totals
74·5– 79·5	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1
79·5– 84·5	1	·5	3·5	—	1	1	—	—	—	—	—	—	—	—	—	—	7
84·5– 89·5	—	1	2	2·25	2·25	1	1	—	1	—	—	—	—	—	—	—	10·5
89·5– 94·5	3	1·5	3·5	6·25	1·25	2	3	3	1	1	—	—	—	—	1	—	26·5
94·5– 99·5	5	1	3	5	5	5	3	2	2	1	—	—	—	1	—	—	33
99·5–104·5	—	—	2	6·5	7·5	14	12	6	5	4·5	3·5	1	—	—	—	—	62
104·5–109·5	1	1·5	3·5	1	8	8·5	3·5	4·5	6·5	1·5	1·5	2	2	—	—	—	45
109·5–114·5	1	1	1	3	3	3	4	5	3	4	3·5	2	1	1	—	—	35·5
114·5–119·5	—	—	—	—	·5	4·5	5	1	—	2	·5	—	—	2	1	1	17·5
119·5–124·5	—	—	—	1	—	—	—	—	1	·5	—	1·5	·5	—	1	—	5·5
124·5–129·5	—	—	—	—	—	—	—	—	—	·5	1	1·5	·5	—	—	—	3·5
Totals ...	11	6·5	18·5	25	28·5	39	32·5	21·5	19·5	15	10	8	4	4	3	1	247

(iii) *Platymeric Index.* ♀ R.

Pilastric Index	64– 66	67– 69	70– 72	73– 75	76– 78	79– 81	82– 84	85– 87	88– 90	91– 93	94– 96	97– 99	100–102	103–105	106–108	109–111	112–114	115–117	Totals
75– 79	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
80– 84	—	·5	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	2·5
85– 89	—	·5	1	1	1	—	—	1	1	1	—	—	—	—	—	—	—	—	6·5
90– 94	1	2	2	2	2	3	3	—	1	—	—	—	—	—	—	—	—	—	16
95– 99	—	—	4	4	2	5	4	1	1	1	2	—	—	—	—	—	—	—	24
100–104	—	1	4	2	5	9·5	9·5	4	2	6	3	1	1	1	—	—	—	—	49
105–109	—	1	—	1	4	3·5	5·5	1·5	4·5	1	2	1	1	—	—	—	—	1	27
110–114	—	—	1	—	4	4	5	3	8	5	2	—	—	2	—	—	—	1	35
115–119	—	—	—	—	4	1	1	3	1	—	1	1	—	—	—	—	—	—	12
120–124	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	2	3
125–129	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	—	—	—	2
130–134	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1
Totals ...	1	5	12	11	22	26	29	15·5	18·5	15	10	3	2	3	1	1	0	4	179

(iv) *Platymeric Index.* ♀ L.

Pilastric Index	64– 66	67– 69	70– 72	73– 75	76– 78	79– 81	82– 84	85– 87	88– 90	91– 93	94– 96	97– 99	100–102	103–105	106–108	109–110	Totals
65– 69	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
70– 74	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
75– 79	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	2
80– 84	—	1	1	1	4	—	1	—	—	—	—	—	—	—	—	—	8
85– 89	—	1	1	5	5	3	1	1	1	1	—	1	—	—	—	—	20
90– 94	2	—	3	3	10	2	4·5	2·5	—	—	1	—	—	—	—	—	28
95– 99	—	—	3	4	4	6·5	4·5	3	—	1	1	1	—	—	—	—	28
100–104	—	—	6	5	6	4	12	5	6	5	—	—	1	—	—	—	50
105–109	—	·5	—	4	5	4·5	1·5	5	3	3	1	1	1	—	1	1	31·5
110–114	—	·5	—	1	—	1	—	5	—	3	—	—	—	—	1	—	11·5
115–119	—	—	—	—	—	3	2	—	1	—	—	1	1	—	1	—	9
120–124	—	—	—	—	—	—	1	—	—	2	—	—	—	—	—	—	3
Totals ...	2	3	14	24	35	24	28·5	21·5	11	15	3	4	3	0	3	1	192

(v) *Pilastric Index.* ♂ R.

Popliteal Index	74·5– 79·5	79·5– 84·5	84·5– 89·5	89·5– 94·5	94·5– 99·5	99·5–104·5	104·5–109·5	109·5–114·5	114·5–119·5	119·5–124·5	124·5–129·5	129·5–134·5	134·5–139·5	139·5–144·5	144·5–149·5	Totals
49·5–53·5	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1
53·5–57·5	—	—	—	1	—	·5	—	—	—	—	—	—	—	—	—	1·5
57·5–61·5	—	—	—	1·5	3	6	3	1	—	—	—	—	—	—	—	14·5
61·5–65·5	1	1	3	2·5	4	6	4·5	1·5	1	—	—	—	—	—	—	24·5
65·5–69·5	—	1	1	6	5	14·5	16	11	8	—	—	—	—	—	—	62·5
69·5–73·5	—	—	1	3	8	9	6·5	10·5	6	2	—	—	—	—	1	47
73·5–77·5	—	—	2	5	—	2	11	11·5	6	3	1	—	—	—	—	41·5
77·5–81·5	—	—	—	1	3	4	4	3·5	5·5	—	—	1	—	—	—	22
81·5–85·5	—	—	—	—	2	2	2	1·5	·5	—	—	—	—	—	—	8
85·5–89·5	—	—	—	—	—	—	1	—	·5	—	—	—	—	—	—	1·5
89·5–93·5	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
Totals ...	1	2	7	21	25	44	49	40·5	27·5	5	1	1	0	0	1	225

(vi) *Pilastric Index.* ♂ L.

Popliteal Index	74·5– 79·5	79·5– 84·5	84·5– 89·5	89·5– 94·5	94·5– 99·5	99·5–104·5	104·5–109·5	109·5–114·5	114·5–119·5	119·5–124·5	124·5–129·5	Totals
49·5–52·5	—	—	—	1	—	—	—	—	—	—	—	1
52·5–55·5	—	—	—	—	—	2	—	—	—	—	—	2
55·5–58·5	—	—	—	—	2	—	1	·5	·5	—	—	4
58·5–61·5	—	2	·25	1·25	2	1	3	—	—	—	—	9·5
61·5–64·5	—	—	2·25	2·25	3	4	4	2	1	—	—	18·5
64·5–67·5	1	—	2	3	4	13	5·5	2	1	1	—	32·5
67·5–70·5	—	1	1	5	5	11·5	7·5	4	2	·5	1·5	39
70·5–73·5	—	4	3	3	4	9·5	7	4	6·5	·5	·5	42
73·5–76·5	—	—	1	4	6	6	6·5	8·5	3·5	1	—	36·5
76·5–79·5	—	—	—	3	2	7	6·5	6·5	2	1	1	29
79·5–82·5	—	—	—	1	1	5	3	2	—	·5	·5	13
82·5–85·5	—	—	—	1	1·5	—	—	3	—	1	—	6·5
85·5–88·5	—	—	—	—	·5	—	—	1	—	—	—	1·5
Totals ...	1	7	9·5	24·5	31	59	44	33·5	16·5	5·5	3·5	235

(vii) *Popliteal Index.* ♀ R.

Pilastric Index	53–55	56–58	59–61	62–64	65–67	68–70	71–73	74–76	77–79	80–82	83–85	86–88	Totals
75– 79	—	—	—	—	—	—	1	—	—	—	—	—	1
80– 84	—	1	—	1·5	—	—	—	1	—	—	—	—	3·5
85– 89	—	—	·5	3	—	1	1	—	—	—	—	—	5·5
90– 94	1	2	3	2	2	2	2	1	1	—	—	—	16
95– 99	—	—	3	8	4	6	1	2	2	—	—	—	26
100–104	—	2·5	5	13·5	11·5	11·5	3	2	—	—	—	—	49
105–109	—	1	1	6	8	4	5·5	1·5	1	—	—	1	29
110–114	—	2·5	2·5	5	5·5	7·5	5	1·5	1·5	—	1	—	32
115–119	—	1	—	—	2	3	3	1	2	—	—	—	12
120–124	—	—	—	—	2	—	—	1	—	—	—	—	3
125–129	—	—	—	—	—	1	—	1	—	—	1	—	3
130–134	—	—	—	—	—	—	—	1	—	—	—	—	1
Totals ...	1	10	15	39	35	36	21·5	13	7·5	0	2	1	181

(viii) *Popliteal Index.* ♀ L.

Pilastric Index	56–58	59–61	62–64	65–67	68–70	71–73	74–76	77–79	80–82	83–85	Totals
75– 79	—	—	2	—	—	—	—	—	—	—	2
80– 84	—	1	—	3	1	1	1	—	—	—	7
85– 89	—	3	4	4	3	3	2	—	—	—	19
90– 94	—	2	5	4	5	6	3·5	1·5	1	—	28
95– 99	1	2	2	6	7	4	4	3	—	—	29
100–104	1	5	5	10	11	4	7	1	4	—	48
105–109	1	3	4	7·5	3	2	4	2	4	—	30·5
110–114	—	—	—	4·5	—	3·5	·5	1	—	—	9·5
115–119	—	—	1	3	1	1·5	1·5	—	·5	·5	9
120–124	—	—	—	—	1	2	—	—	—	—	3
Totals ...	3	16	23	42	32	27	23·5	8·5	9·5	0·5	185

(ix) *Platymeric Index.* ♂ R.

Popliteal Index	63·5– 66·5	66·5– 69·5	69·5– 72·5	72·5– 75·5	75·5– 78·5	78·5– 81·5	81·5– 84·5	84·5– 87·5	87·5– 90·5	90·5– 93·5	93·5– 96·5	96·5– 99·5	99·5–102·5	102·5–105·5	105·5–108·5	108·5–111·5	111·5–114·5	114·5–117·5	Totals
49·5–53·5	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1
53·5–57·5	—	—	—	—	—	1	·5	—	—	—	—	—	—	—	—	—	—	—	1·5
57·5–61·5	—	—	·5	—	1	3·5	3·5	2	1	1	—	1	—	—	—	—	—	—	13·5
61·5–65·5	—	1	2·5	3	4	3·5	2	3	2	—	1	—	2·5	—	—	—	—	—	24·5
65·5–69·5	2	—	2	6·5	7	4	7	9	4·5	8	2	4	4·5	1	1	—	—	—	62·5
69·5–73·5	—	—	—	4·5	6	6	8	6·5	4	5	2	2	1	—	1	—	—	1	47
73·5–77·5	—	1	2	2·5	1·5	4	9	7	5	4	1	1	3·5	—	—	—	—	—	41·5
77·5–81·5	—	—	1	·5	1·5	4	2·25	3·75	3·5	2	1	—	1·5	1	—	—	—	—	22
81·5–85·5	—	—	—	—	1	1	2·25	1·25	—	1	·5	1	—	—	—	—	—	—	8
85·5–89·5	—	—	—	—	—	—	—	1	—	·5	—	—	—	—	—	—	—	—	1·5
89·5–93·5	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1
Totals	2	2	8	17	22	27	34·5	34·5	20	21·5	8·5	9	13	2	2	0	0	1	224

(x) *Platymeric Index.* ♂ L.

Popliteal Index	66·5– 69·5	69·5– 72·5	72·5– 75·5	75·5– 78·5	78·5– 81·5	81·5– 84·5	84·5– 87·5	87·5– 90·5	90·5– 93·5	93·5– 96·5	96·5– 99·5	99·5–102·5	102·5–105·5	105·5–108·5	108·5–111·5	111·5–114·5	Totals
49·5–52·5	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
52·5–55·5	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	—	2
55·5–58·5	—	—	—	1	1	—	—	—	—	—	1	1	—	—	—	—	4
58·5–61·5	—	·5	1·5	1·25	1·25	1·5	2·5	—	1	—	—	—	—	—	—	—	9·5
61·5–64·5	2	—	3	2·25	3·25	1	3	2	—	3	—	—	—	—	—	—	19·5
64·5–67·5	1	1	1	3	6	8·5	5	2	1	—	1	1	—	—	2	—	32·5
67·5–70·5	—	—	4	5·5	7·5	2·5	6·5	5	4	—	2	—	1	1	—	—	39
70·5–73·5	4	1	4	6	3	8	4·5	3	5	1	1	—	—	1	—	·5	42
73·5–76·5	1	1·5	1·5	3	3	6·5	7	2	1	3·5	1·5	2	1·5	—	—	·5	35·5
76·5–79·5	2	1	1	1	1·5	6	1	5	2	4·5	1·5	2	·5	—	—	—	29
79·5–82·5	—	·5	1·5	1	—	2	—	·5	2·5	—	1	1	1	1	—	—	12
82·5–85·5	1	·5	—	—	—	2	—	1	1	—	—	—	—	—	—	—	5·5
85·5–88·5	—	·5	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1·5
Totals	11	6·5	17·5	25	27·5	38	30·5	20·5	17·5	13	9	7	4	3	2	1	233

(xi) *Platymeric Index.* ♀ R.

Popliteal Index	64– 66	67– 69	70– 72	73– 75	76– 78	79– 81	82– 84	85– 87	88– 90	91– 93	94– 96	97– 99	100–102	103–105	106–108	109–111	112–114	115–117	Totals
53–55	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
56–58	—	—	1	—	1·5	2	3	1	—	—	·5	—	—	—	—	—	—	—	9
59–61	—	—	3	—	3	2	2·25	1·25	1	—	1·5	—	—	—	—	—	—	1	15
62–64	—	3	3	2	1·5	6	7·75	4·75	2	2	2	—	1	2	—	—	—	—	37
65–67	—	2	2	3	7	4·5	4·5	—	1	3	3	2	1	—	—	1	—	1	35
68–70	—	—	3	1	2	6	4	2·5	6·5	4	3	1	—	1	—	—	—	—	34
71–73	—	—	—	—	3	2·5	5	3	5	2	—	—	—	—	—	—	—	—	20·5
74–76	—	—	—	3	1	3	·5	1	—	2	—	—	—	—	1	—	—	1·5	13
77–79	—	—	—	—	2	—	1	1·5	1·5	—	—	—	—	—	—	—	—	·5	6·5
80–82	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
83–85	—	—	—	—	—	—	—	·5	·5	—	—	—	—	—	—	—	—	—	1
86–88	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Totals	1	5	12	10	21	26	28	15·5	17·5	13	10	3	2	3	1	1	0	4	173

(xii) *Platymeric Index.* ♀ L.

Popliteal Index	64– 66	67– 69	70– 72	73– 75	76– 78	79– 81	82– 84	85– 87	88– 90	91– 93	94– 96	97– 99	100–102	103–105	106–108	109–111	Totals
56–58	—	—	1	—	—	—	1	—	—	1	—	—	—	—	—	—	3
59–61	—	1	2	3	3	1	1	3	1	—	—	1	—	—	—	—	16
62–64	—	—	1	6	7·5	2·5	1·5	2	·5	3	—	—	—	—	—	—	24
65–67	—	1	2	5	5·5	9	5	4·5	3·5	3	—	—	·5	—	2	1	42
68–70	—	—	—	6	5	5·5	6	3	2	1	—	—	2·5	—	—	—	31
71–73	1	1	4	2	5	1	4	3	1·5	3·5	1	—	—	—	—	—	27
74–76	1	—	2·5	1	4	3	5	2	1·5	1·5	1	1	—	—	—	—	23·5
77–79	—	—	·5	—	2	—	2	—	1	—	1	1	—	—	—	—	7·5
80–82	—	—	1	—	1	·5	1	3	—	1	—	1	—	—	—	—	8·5
83–85	—	—	—	—	—	·5	—	—	—	—	—	—	—	—	—	—	0·5
86–88	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
89–91	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0
Totals	2	3	14	23	33	23	26·5	20·5	11	14	3	4	3·	0	2	1	183

VII. *The Bowing of the Femur.*

We were able to measure the indices of bowing in 41 young bones. In 25 of these the epiphyses were absent, and the neck was so little developed that no neck measurements could be taken. In 9 bones, although the epiphyses were absent or in part absent so that no length could be taken, the neck was formed, so that neck measurements were possible. In 7 bones the epiphyses were present so that the maximum length could be taken, but the epiphyses were not fully fused. We were thus able to make five broad age divisions, each containing, however, only roughly seven bones. The results were as follows:

	Age Group. Both Sexes	Primary Index of Bowing	Secondary Index of Bowing	
A	No Epiphyses, Diaphysial Length* < 25 cms. ...	2·45	37·14	
B	„ „ „ 25 to 30 cms.	2·78	39·05	
C	„ „ „ > 30 cms. ...	3·03	40·14	
D	Epiphyses imperfect, Neck formed	2·89	35·20	40·63
E	Epiphyses formed	2·61	47·60	
F	Adult Bones ♂ (R. + L.)	2·55	37·85	
F′	„ „ ♀ (R. + L.)	2·50	41·14	

* This is not the diaphysial chord used in our index of bowing, *i.e.* the distance from platymeric to popliteal section, but the length from epiphysial border to epiphysial border taken as accurately as the case permitted with the tape or calipers. In determining the bowing chord the popliteal section was taken at $\frac{1}{10}$ of this diaphysial length from the epiphysial border.

If these figures for non-adults could be considered as based on numerically adequate data—which is far from the case—we should conclude that bowing increases from infancy through childhood to about four years of age and then diminishes to the adult condition when it has again about the infantile value. Whether there is a real maximum of bowing at about four years of age seems to us doubtful even if the above numbers are valid, because it is more than probable that our sample of children is not a random selection, but that the individuals who die in childhood have on the whole less healthy and normal bones. We believe that Guldberg[1] is incorrect in speaking of a flat femur as of *infantile type*; it is very difficult to appreciate the curvature in a very short length, and naturally if he has judged as appears by the subtense only, this would be much smaller for an infantile bone than an adult one. We cannot accept the position that the eye can judge a "flat" bone; the length of the arc makes a very appreciable difference in our judgment of its curvature, and we believe that without actually determining the ratio of subtense to chord, it is not safe to appreciate bowing by the eye. If R be the radius of curvature of the diaphysis, A_1 the diaphysial chord, A_2 the diaphysial subtense, then if we assume with Antony and Rivet[2] that the bowing is in a circle, we have

$$R = \tfrac{1}{2}A_2 + \tfrac{1}{8}A_1^2/A_2 = 12{\cdot}5\,A_1/B$$

[1] Bibl. 93, S. 295.

[2] Bibl. 97.

nearly, where B is the index of bowing. Thus if R is to become infinite or the curvature zero with infancy, we must have, since A_1 becomes smaller and smaller, the index of bowing B decreasing as we go back at a very rapid rate. We do not, however, find this to be the case; the index of bowing remains relatively constant and the chord increases rapidly with age. Thus R is greater for the adult than the child or the curvature is less[1]. We have as a matter of fact for our five groups in terms of curvature:

Children under 5 years	A	·0115	·0110 cm.$^{-1}$.
	B	·0116	
	C	·0100	
Neck or Epiphyses formed	D	·0095	·0094* cm.$^{-1}$.
	E	·0094	
Adults	F		·0083 cm.$^{-1}$ (according to our data). ·0097 cm.$^{-1}$ (according to Antony and Rivet).

* Guldberg (Bibl. 93, S. 296) found the curvature in children of 8 to 12 the same as that of adults.

It appears to us therefore that absence of bowing as a mark of *infancy* is an incorrect conception. At the same time we have only very slender data for fetal bowing. The fetal femur has been asserted to be straight, but we are inclined to believe that the judgment of its flatness has probably been made like that of the infant on the smallness of the subtense[1]. Extreme bowing in cases of rachitis may be due to mechanical influences, but that bowing in the normal human being is a product of the weight of the body seems incompatible with the decrease of curvature with the approach to adult life.

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[1] There is a good deal of confusion in the anatomical or anthropometric use of the word curvature. It often appears to refer to the radius of curvature R and not to the mathematical curvature $1/R$. Antony and Rivet take the mean R; but do not appear to recognise that the inverse of the mean R is not the mean curvature, *i.e.* mean value of $1/R$, although their conclusions are drawn in terms of curvature. Thus the 26 gorilla femora they give have a mean curvature of ·0139, the inverse of which is 71·9 cms., while the mean radius of curvature is 79·8 cms. [A. and R. give it as still higher, 84·1, but this arises from their using the mean radius only in the case of *paired* bones]. The difficulty is admirably illustrated in the case of the gibbons, where two out of 15 femora are said to have $R=\infty$. The mean value of R is accordingly infinite and the inverse of mean R would be zero. Thus these two femora must either be arbitrarily omitted, or more refined measurements taken to find their R. If we take the *curvature*, the mean value for the 15 gibbons is ·005354, corresponding to an inverse of mean curvature of 186·8 *cms.*—a radius higher than that of the gorillas, but by no means infinite. Had we taken the mean radius of curvature of the 13 finite values the result would have been 287·3 cms. The same 13 give for mean curvature the value ·006178, leading to an inverse of 161·9 cms. It will be seen from this illustration that if curvature and not an index of bowing is to be adopted we can only avoid asserting that the gibbons have an infinite mean radius of curvature by starting with the curvatures and not the radii of curvature. In this case according to the data of Antony and Rivet the

mean curvature of the femur in Man ... = ·0096*
" " " " Woman = ·0097
" " " " the Gorilla = ·0139
" " " " the Gibbon = ·0054

while infants and children under five give according to our data a value of about ·0110. It will be seen that if the infant be nearer to the gorilla, the adult is nearer to the gibbon, and we have another case—if it be in an inverse manner—of what has been termed the "scission qui se fait dans l'ordre des Primates."

* Using mean values our results give in Man ·0079, in Woman ·0087. The differences must be racial; they can scarcely be due to the fact that we have worked with the diaphysial chord from popliteal to platymeric section, while Antony and Rivet take the entire diaphysial length. For, owing to the flattening of the anterior face as we approach the epiphyses, A_2 is increased while A_1 remains nearly constant, thus R would be exaggerated and their curvature $1/R$ diminished. As we have already indicated, the secondary index of bowing shows the unsatisfactory character of R.

Guldberg has considered without providing quantitative determination the skewness of the bowing. He writes: "diese Krümmung hat gewöhnlich ihre grösste Hohe ungefähr in der Mitte oder etwas näher dem proximalen Ende, dagegen viel seltener näher dem distalen Ende[2]."

Our secondary index of bowing has been devised to describe this skewness adequately. It will be seen that the point of maximum curvature divides the diaphysial chord in about the ratio of 2 to 3, so that point is substantially nearer the proximal end, certainly this point is not "ungefähr in der Mitte." Our data only shows 4·4 °/$_\circ$ of male bones with the maximum of curvature nearer the distal end, and 14·7 °/$_\circ$ of female bones. This apparent sexual difference is marked by secondary indices of bowing of 37·85 and 40·14 respectively. Thus the curvature of the female thigh-bone reaches its maximum at a slightly lower point than the male, but on the other hand it appears to be slightly less (primary indices 2·57 and 2·49 respectively). The mean secondary index for children's bones is 39·98, which lies between the results obtained for male and female adults and very near their mean 39·49, and is therefore compatible with no change in this index with growth. The results for the non-adult bones are somewhat erratic, but there is some indication of increase of index with age, or a suggestion that the proximal end might develop more rapidly than the distal if we suppose the point of maximum curvature not to shift relative to the material of the shaft[1]. The series is too slender, however, for us to risk more than a suggestion.

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[1] *Bowing of the Fetal Femur.* We do not know how bowing has been measured on the fetal femur by others. The bones of the fetal skeleton are so plastic and liable to set and distort in the process of mounting that little confidence can be placed in measurements made upon the dry fetus as representing the actual fetal condition. Further the quantities to be measured are so small that great errors are likely to occur. Accordingly every one of the present values is to be considered extremely doubtful. Taken as a whole, however, they do not seem to support the view that the fetal femur is *flat.* Our measurements were made by taking a thin bit of lead ribbon, cutting off a length equal to the distance between the assumed popliteal and platymeric sections, bending this to the anterior surface of the femur, then placing it on its edge on a sheet of paper and drawing the curved line of the anterior face from this lead ribbon with a fine pencil on the paper. The chord and subtense of this arc were then measured and the distance of the subtense from the proximal end of the chord. We have to thank Professor Wood Jones for most kindly placing six dry preparations at our disposal.

First Fetus, R. and L. Diaphysial Length 6·90 cms. The torsion is so great that the plane of the anterior face at the proximal epiphysis border is rotated so as to be almost perpendicular to the plane of the anterior face at the distal epiphysis border. This rotation brings the mesial boundary of the upper half of the anterior face into the sagittal plane of the lower half of the anterior face, and the lead strip has either to be given a double curvature in space, or will show even a slight negative curvature when brought against the mesial boundary. This torsion formed a difficulty—although not so complete—in other cases and the position of the lead ribbon had to be a compromise.

Second Fetus, R. and L. Diaphysial Length 6·41 cms. Primary Index of Bowing, R. 2·56, L. 2·34; Secondary Index, R. 50·0, L. 60·0.

Third Fetus, R. and L. Diaphysial Length 5·23 cms. Primary Index of Bowing, R. 2·29, L. 2·26; Secondary Index, R. 48·0, L. 48·0.

Fourth Fetus, R. and L. Diaphysial Length 4·40 cms. Primary Index of Bowing, R. 3·21, L. 3·17; Secondary Index, R. 57·1, L. 42·1.

Fifth Fetus, R. and L. Diaphysial Length 3·30 cms. Primary Index of Bowing, R. 3·71, L. 2·92; Secondary Index, R. 36·75, L. 35·67.

Sixth Fetus, R. and L. Diaphysial Length 2·65 cms. Primary Index of Bowing, R. 4·44, L. 4·00; Secondary Index, R. 66·7, L. 46·7.

Mean Fetal Primary Index of Bowing 3·09, Mean Secondary Index 48·7.

We believe that the sole reliable inferences to be drawn from these results are (i) that the fetal femur is not flat and (ii) that the point of maximum bowing is near the middle of the shaft—perhaps more nearly so than later in life.

[2] Bibl. 93, S. 294.

Guldberg[2], judging from Dubois' plates, considers the femur of *Pithecanthropus* to be of "infantile type," *i.e.* to be flat. The indices of bowing are, as far as can[3] be determined from the photographs:—Primary: 2·76, Secondary: 51·7, and do not seem peculiarly "infantile" or indeed flat.

In attempting to compare our results with those of Antony and Rivet[4] we meet with many difficulties. In the first place they use the radius of curvature R obtained from the formula $R=(A_1^2+4A_2^2)/(8A_2)$, a formula which wholly neglects the fact that the secondary index of bowing is far from 50. In the next place their frequency distributions being:

R =	50–70	70–90	90–100	100–130	130–150	150–170	170–190	190–210	210–230	230–250	250–270	Totals
♂	2*	16	14	12	7	4	—	2*	1*	1*	—	59
♀	4	9	9	6	3	3	4	—	1*	—	1*	40

they eliminate the eight femora we have marked with asterisks as being non-continuous with the rest of their frequency distributions. But such discontinuity must always occur with small samples, and although they may have other reasons not stated, one cannot legitimately discard these measurements on the ground merely of discontinuity[1]. Further their material is racially very different from ours, consisting of 100 femora of prehistoric Columbian Indians.

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[1] This appears contrary to the usual statement that growth in length of femur takes place chiefly from the lower epiphysis (Gray's *Anatomy*, 17th edn., 1909, p. 340), but it must be remembered that our method of obtaining the curvature excludes from consideration the flatter portions of the shaft in the immediate neighbourhood of the epiphyses, and when these are included, the relative growth may be much modified. See however the footnote on the previous page as to the fetal secondary index.

[2] Bibl. 93, S. 298.

[3] As far as we can judge both the photograph (S. 17, Fig. 3*b*) and the plate (Pl. II, Fig. 2) of Dubois' monograph (Bibl. 67 *bis*) lead to the same results, *i.e.* a diaphysial chord of 29 cms. and a diaphysial subtense of 0·8 cm.—both measured in our manner. According to these our index of bowing for the Trinil femur would be 2·76 and the curvature in Antony and Rivet's sense would be ·0076. The modern human femur with which the Trinil femur is compared (S. 17) has an index of bowing of about 3·00 and a curvature of about ·0086. As far as it is possible to estimate on these photographs, the secondary indices of bowing are 51·7 and 35·7 for the Trinil and modern human femora respectively. It is rather the secondary than the primary index of bowing which is noteworthy in the Trinil femur but neither index is beyond the range of very common values in the human femur. Probably the comparison with a rather more bowed femur on S. 17 of Dubois' monograph, and his remark on S. 18 ("Das Mittelstück ist etwas weniger convex nach vorne gebogen als beim Menschen") has led to a somewhat hasty assumption that there is an absence of any bowing.

[4] Bibl. 97.

Using their material we find for the radius of curvature in cm. units[2]:

		Mean	Standard Deviation
Columbian Indians	♂	114·0	35·73
	♀	118·5	44·53

The female is thus more variable and has a slightly flatter femur than the male. We can now compare these conclusions with our own results[3].

Character	Sex	Bone	Number	Mean	Standard Deviation
Primary Index of Bowing	♂	R.	234	2·587 ± ·031	·699 ± ·022
	♂	L.	242	2·515 ± ·029	·660 ± ·020
	♀	R.	172	2·503 ± ·037	·716 ± ·026
	♀	L.	189	2·501 ± ·033	·673 ± ·023
Secondary Index of Bowing	♂	R.	240	37·09 ± ·29	6·74 ± ·21
	♂	L.	242	38·60 ± ·33	7·57 ± ·23
	♀	R.	170	39·47 ± ·48	9·27 ± ·34
	♀	L.	190	42·62 ± ·44	8·99 ± ·31

We see at once that in the primary index of bowing the differences between male and female both in mean and variability are of the order of the probable error of the differences. The differences such as they are indicate that the female femur is less bowed and more variable than the male—which is in agreement with Antony and Rivet's far more slender data[4]. But, having regard to the probable errors, the difference if any is so slight that far more material would be needful before any definite assertion could be made, and then so slender a distinction could not be used as a classificatory sex difference. On the other hand we are justified in asserting that the point of maximum curvature of the anterior surface of the femur is more median in the female than the male and that the position of it is more variable. Here again the differences although quite significant form only an average class distinction and would be of small service for differentiating individual bones.

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[1] *Loc. cit.* p. 232.

[2] From smaller grouping than above.

[3] The only comparable data beyond those considered above are due to Mollison (Bibl. 100, p. 588). He has quite sound views of how bowing is to be determined, and we think if his method of determining the proximal end of his diaphysial chord be not absolutely identical with ours still his index of bowing is quite reasonably comparable. Unfortunately his material is of the slenderest; he gives for six unsexed Maori femora, R. + L.: Index of Bowing 2·48 (range 1·4 to 3·4). On this evidence there is apparently no difference in the extent of bowing between a primitive race like the Maori and our 17th century Londoners.

[4] On the other hand if we treat the *curvature* obtained from the mean values of subtense and chord we find: Men ·0079 and Women ·0087, *i.e.* the women have more curvature, or using Antony and Rivet's process, we get the *opposite* of their result. We do not think there is any real sexual differentiation.

We are able on the basis of the above data to consider Antony and Rivet's further statement that the bowing is greater in the right than the left bone. If we were to trust to our decimal places this would be a correct assertion, but the probable errors show that no credit can be given to the second, much less the third place of decimals. Thus the only conclusion we can base on our data is that if there be a real distinction between the curvature of right and left femur our material and therefore *a fortiori* Antony and Rivet's is too inadequate to demonstrate its existence[1]. On the other hand the left femur has its point of maximum curvature on the average in a position further removed from the proximal epiphysis than the right. This is significant having regard to the probable error of the difference in both male and female. In the case of both indices for three cases the right bone is more variable than the left, but the differences are not significant with regard to the probable error of the differences. In the fourth case, that of the male secondary index where the difference (·83) is more than 2·5 times the probable error (·31), and we might begin to suspect significance, the left is more variable than the right, and we must accordingly conclude that our data do not suffice to show that as a rule right or left side has a preponderating variability.

Antony and Rivet now proceed to a number of conclusions bearing on the possibility of a mechanical origin of the flexure. Following Manouvrier they seem inclined to reject theories of any mechanical origin. Manouvrier had stated that there was no bowing in children—a conclusion with which we are unable to agree—and had attributed bowing in general to a "compensating effect," corresponding to a development of the pilaster, due to the extension of the surface of insertion of the crural muscle[2]. It will be seen that this attitude is one with that which attributes the development of the third trochanter and the *fossa hypotrochanterica* to direct muscular action. Difficulties arise, suggested partly by supporters of the older mechanical theory who point to the bowing which so often is associated with rachitic and non-muscular bones, and partly by those who draw attention to the bowing in the case of the apes where there may be bowing and no pilaster to require "compensating effect": see our Plate LIII showing bowing in the femur of the gorilla with absence of the pilaster. To these arguments we might rejoin in the first case that because in a diseased bone bowing may be due to mechanical causes, it does not follow that such is the whole source or even the source at all of it in normal bones. In the second case Antony and Rivet themselves endeavour to explain the considerable curvature in the gorilla and chimpanzee with the small pilastric development by their arboreal progression by aid of their upper limbs. Their prevalent position on trees with bent knees requires the adductor muscle to reach the posterior face of the femur and to keep clear of it; hence the posterior face is scooped out and there is a compensatory frontal development[3]. It would thus seem that absence of the pilaster in the apes and presence in man both lead to a "compensatory effect" in bowing. Whatever may be said of the argument, it is clear that the first question we must answer is to what intensity is the index of bowing associated with the pilaster? We must correlate the index of bowing and the pilastric index. Antony and Rivet do not write with knowledge of the modern theory of correlation, but they group their limited material into three classes of large, moderate and small character, pilastric index, say, average these classes and place against each group its mean radius of curvature. The danger of this method is considerable, not only in that it fails to give us a quantitative measure of the correlationship, but that in such inadequate material a flat bone immensely modifies the mean of any class. The following is their table:

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[1] Bumüller (Bibl. 81, S. 44) states that he found L. (128) 6° 40′ and R. (127) 8° 15′ for his *Krümmungswinkel*. We do not, however, accept this measure of bowing and Bumüller is quite probably recording a characteristic wholly different from ours.

[2] Bibl. 57.

[3] Bibl. 97, pp. 258—9.

	♂			♀		
Group	No.	Pilastric Index	Radius R.	No.	Pilastric Index	Radius R.
First	20	118·3	96·3	11	115·6	106·0
Second ...	19	111·5	110·4	12	108·0	110·9
Third ...	14	105·0	126·1	14	103·2	118·3

The table shows that where the curvature $\left(\frac{1}{R}\right)$ is greatest the pilastric index is greatest. But the result is based on the by no means justified exclusion of six male and three female bones.

Taken from Antony and Rivet's data for the apes and our data for man we have the following comparative table[1]:

Species	No.	Curvature	Pilastric Index	Platymeric Index	Cervical Index	Angle of Neck and Shaft	Obliquity	Torsion
Pithecanthropus	1	·0000(?)	109·1	[94·0?]	?	125°·0	12°·0	15°·0
Gibbon ...	15	·0054	97·0	91·2(?)	80·9	125°·8	1°·96	8°·0
Orang	4	·0069	78·8	71·8	71·9	138°·0	1°·8	[–5°·65]
Man	476	·0096	104·5	85·2	75·7	130°·9	10°·14	13°·2
Woman ...	361	·0097	101·7	82·9	77·0	129°·8	10°·58	16°·1
Chimpanzee ...	19	·0129	85·9	84·2	84·1	127°·1	2°·12	3°·7
Gorilla	26	·0139	76·8	82·1	74·8	122°·5	2°·75	0°·9(?)

There appears to be no correlation interracially between any of these characters and the curvature. All that comes out of such a table is (i) further illustration of the "scission of the primates" and (ii) the close accordance of the Trinil femur with

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[1] The means for somewhat larger numbers of ape femora for certain of the characters are given by Rodriguez (Bibl. 101) without essential modifications, *i.e.*

Species	No.	Pilastric Index	Platymeric Index	Angle of Neck and Shaft	Torsion
Orang	5	78·47	71·24	136°·8	–3°·9
Chimpanzee ...	24	84·62	82·76	125°·6	+5°·4
Gibbon	23	97·07	82·83*	124°·2	+8°·4
Gorilla	41	75·38	81·04	121°·6	+7°·7*

* These characters show the most divergence from the table above. Our values are 83·7 and 7°·5 respectively, substantially agreeing with Rodriguez.

the human femur. So close is this that we ventured to hesitate before accepting its radius of curvature as "circa ∞," and found it to be ·0076, quite human[1]. Intraracially we have now to investigate what our own data show for the pilastric index.

Correlation of Primary Index of Bowing and Pilastric Index.

♂		♀	
R.	L.	R.	L.
·257 ± ·041	·223 ± ·041	·229 ± ·049	·192 ± ·048

It is clear therefore that intraracially the pilastric index is significantly, although only moderately, correlated with the bowing. The more the pilaster is developed the greater the bowing. But the association is hardly so marked that we can look upon the one as a primary source of the other. The bowing appears to be related in some secondary manner to the pilastric development. It would be risky to hold that one is the outcome of the other[2]. Turning from Manouvrier's theory of "compensating effect" we may now investigate certain correlations which bear on the theory of mechanical influence. Antony and Rivet found no relationship between the absolute size of the bone and its curvature[3]. We have considered the maximum length of the femur and the primary index of bowing, but we feared spurious correlation, the length including the diaphysial chord as part of itself. Accordingly we took the bicondylar width as a good measure of the size of the bone, and again the capito-collar length as to some extent measuring the leverage.

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[1] See the third footnote p. 279 above.

[2] Bumüller (Bibl. 81, S. 38) gives the following table which he says is based on 245 femora (? sides and sexes pooled):

Pilastric Index	Below 90	90—100	100—110	110—120	Over 120
Mean Angle of Curvature	With Pilaster 5° 40′ Without Pilaster 7° } 6°	7° 7° } 7°	7° 30′	9°	9° 30′

We are not, however, able to accept Bumüller's *Krümmungswinkel* as a scientific measure of curvature. He deduces from the above results that the pilaster is not the primary source of bowing. Bumüller (*loc. cit.* S. 41) also investigates the association in about 50 femora (? side and sex) of his angle of curvature and the index 100 platymeric/pilastric antero-posterior diameter. The data are too few to provide definite results.

[3] They give the following table, and although the differences of the groups are just as marked as in their table of the pilastric index, they do not consider them of any value because the two variates show no systematic changes; they even suggest that the irregularities may be due to erroneous sexing.

		♂			♀	
	No.	Oblique Length	Radius *R*.	No.	Oblique Length	Radius *R*.
1st Group ...	15	427·5	113·9	11	391·0	102·6
2nd Group ..	14	411·3	113·9	12	369·5	117·4
3rd Group ...	17	395·9	103·9	10	356·8	104·8

None of these indicate any persistent relationship at all between the size of bone and the bowing, as the following table indicates:

Correlation of Bowing with Absolute Femoral Lengths.

Index of Bowing with	♂		♀	
	R.+L.		R.+L.	
Maximum Length ...	− ·041 ± ·032		− ·019 ± ·037	
	R.	L.	R.	L.
Bicondylar Width ...	− ·068 ± ·055	− ·144 ± ·052	− ·248 ± ·064	+ ·017 ± ·064
Capito-collar Length ...	− ·136 ± ·044	+ ·066 ± ·045	+ ·009 ± ·053	+ ·023 ± ·050

It may be considered that what we need is not absolute size, but some measure of the slenderness of the bone to correlate with the bowing—a long slender bone would be more subject to mechanical effect. Accordingly we correlated the index of robusticity, *i.e.* 100 sum of pilastric diameters/oblique length with the bowing and found the following values:

Correlation of Indices of Bowing and Robusticity.

♂, R.	♂, L.	♀, R.	♀, L.
+ ·368 ± ·041	+ ·159 ± ·045	+ ·262 ± ·051	+ ·176 ± ·052

These values are significant if not very large, the right bones showing higher correlation than the left. But they tell exactly against the mechanical influence theory—the more robust bones being the more bowed. This is probably only another path to the old conclusion that bowed bones tend to have a larger pilastric antero-posterior diameter[1]. Beyond these correlations we have calculated a number of others as a means of testing the conclusions reached by Antony and Rivet on our wider material by more adequate statistical methods. We give first Antony and Rivet's conclusion and then follow it with our own.

A. + R.'s statement: *Curvature has no relation to the Platymeric Index.*

Our material	♂, R.	♂, L.	♀, R.	♀, L.
Index of Bowing and Platymeric Index	+ ·061 ± ·044	+ ·097 ± ·043	− ·069 ± ·051	+ ·009 ± ·049

The correlations are non-significant and not always of same sign. Antony and Rivet's conclusion is confirmed. We have investigated the Popliteal Index also. Thus:

Our material	♂, R.	♂, L.	♀, R.	♀, L.
Index of Bowing and Popliteal Index	− ·097 ± ·045	− ·004 ± ·044	+ ·044 ± ·052	− ·094 ± ·049

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[1] Antony and Rivet (Bibl. 97, p. 255) conclude that the bowing is slightly more accentuated in the robuster bones, but we do not consider this result justified by their data. Their classes show very irregular values of R, and in the case of the female bones the least robust show the greatest curvature.

The correlations are non-significant. Thus the flattening of the bone beyond our diaphysial chord seems to have no influence on the bowing.

A. + R.'s statement: *Curvature is least where the obliquity is greatest.*

Our material	♂, R.	♂, L.	♀, R.	♀, L.
Obliquity and Index of Bowing ...	− ·004 ± ·046	+ ·056 ± ·044	− ·179 ± ·052	+ ·107 ± ·051

The correlations are scarcely significant and not even of the same sign. We think Antony and Rivet's conclusion cannot be confirmed.

A. + R.'s statement: *Curvature has no relation to the shape of the neck.*

We have correlated the Index of neck = 100 horizontal diameter of the neck/vertical diameter of the neck with the index of bowing, and find:

Our material	♂, R. + L.	♀, R. + L.
Primary Index of Neck and Index of Bowing	− ·112 ± ·031	+ ·003 ± ·037

There is no relationship in the case of the female bones; there is a possibly just significant relationship but one of no importance in the case of the male bones. What relation there is, however, indicates that the rounder the neck the less the bowing.

A. + R.'s statement: *The smaller the cervical angle the greater the curvature.*

Our material	♂, R. + L.	♀, R. + L.
Angle of Neck and Shaft and Index of Bowing	− ·054 ± ·031	− ·081 ± ·036

Thus the sign of Antony and Rivet's correlation is confirmed, but the values can scarcely be called significant relative to their probable errors. We do not think that the angle of neck and shaft has really any sensible "mechanical effect" on the bowing. Lastly we take the torsion of the *shaft*, *i.e.* not that of the femur, as a whole, and find:

Our material	♂, R.	♂, L.	♀, R.	♀, L.
Torsion of Shaft and Index of Bowing	− ·143 ± ·045	− ·195 ± ·044	− ·078 ± ·053	− ·091 ± ·052

Our signs are consistently negative, although only the male values can be considered definitely significant. We conclude that the more torsion of the shaft the *less* it is bowed. This is definitely opposed to Antony and Rivet's conclusion that the larger the torsion the greater the curvature is, but they are using torsion for the whole femur, including the retorsion of head and neck. It seemed to us better to use the torsion of the shaft only as we were considering the bowing of the shaft. We have, however, considered the correlation of the torsion for the whole femur with the primary index of bowing. We find:

Our material	♂, R.	♂, L.	♀, R.	♀, L.
Correlation of Bowing and Torsion ...	− ·023 ± ·047	− ·106 ± ·046	− ·052 ± ·056	− ·037 ± ·054

These are all *less* than the correlations of torsion of shaft with bowing; they are, however, all of the same *negative* sign, although individually insignificant. We cannot therefore confirm Antony and Rivet's view that the larger the torsion the greater the curvature; it certainly is not true for our index of bowing. On the contrary we think it probable that torsion is a secondary means of attaining the same end as bowing.

To sum up: There are no close correlations between the bowing of the femur and any of its component parts or characters upon which we might suppose the "mechanical effect" to depend. We can find no evidence therefore for the theory of mechanical influence being the source of the normal or physiological bowing of the femur—the source of bowing in diseased femora is not necessarily the source in the normal bone. There is a definite, if small, correlation between torsion and bowing, the more torsion the less bowing. This is a clue which might prove of some interest; the effect of torsion would be to rotate slightly the platymeric end of the shaft so as to bring its transverse diameter more nearly into the plane of bending and so strengthen the shaft considered as a strut. The retorsion of the neck and head would result as a readjustment of the torsion of the shaft arising as a strengthening factor against bending. As one serves to some extent the purpose of the other, it is not so surprising to find bowing and torsion negatively correlated. At the same time the torsion would tend merely from geometrical considerations to cause the bone to present a flatter or less bowed anterior surface. It would thus be seen that the development of the pilaster with bowing and the extensive torsion of the shaft in the case of the human femur may really be due to one and the same physiological necessity—and form two fundamental methods of strengthening the femur to carry its vertical load by increasing the diameter in the plane of buckling. From this standpoint bowing and pilastric development are not effect and cause; they are not due to a compensatory principle, but are both physiological endeavours to obtain a big diameter in the weakest buckling plane. In precisely the same way as the Greeks had learnt to slightly bulge their columns to give increased strength, so the bowing is a bulge to strengthen the cross-sections in proportion to their respective weakness. In fact if we could solve the elastic problem of bending in a column so complicated in form, and with so numerous force applications as in the muscular attachments, as the femur we might well find that the secondary index of bowing was determined by the elastic conditions of the problem itself on the plan of the "solid of equal resistance." We conclude then from the two correlations with bowing that are really of importance, that with the pilastric index (including the index of robusticity) and that with the torsion of the shaft, that bowing is not due to mechanical influences during growth, but is a physiological development (arising in the course of evolution by selection) tending to produce a column of greater and more uniform strength for the purpose of carrying a vertical load. In coming to this conclusion we do not deny that a diseased bone may bow owing to mechanical influence, and that the compression on the posterior face may lead to a pilastric development—rather the inverse of Manouvrier's compensation principle—but we gravely doubt whether such extreme cases as may be seen in our Plates XXXIII—XXXV can be used as an argument as to what happens in healthy bones developing normally. Even if such were the immediate source of growth to the desirable form—a moderately bowed bone with a considerable pilaster—it does not follow that the ultimate reason for this form is not the "solid of equal resistance" conception; it would merely indicate that the growth factors had been adapted to the required end[1].

VIII. *On the Curvature of the Popliteal Area.*

We have already discussed this point at some length when dealing with the measurement of the popliteal index. The main point from which the importance of a determination of the curvature arises is that the sign of the curvature has been taken as a character differentiating man from the anthropoid apes, and Dubois[2] emphasises the convexity of the Trinil femur as a factor which makes it essentially apelike amid very human general features. We tested the flatness[3] at the popliteal section (taken at 4 cms. in man: see our p. 9) and at $\frac{1}{10}$ the diaphysial length in the apes. We examined 23 femora of the orang-utan; the femur was sensibly convex in 19 cases, convex although approaching to flat in two and flat in two only; there was no case of concavity. We examined 20 femora of the chimpanzee; of these 17 were sensibly convex, two were, we hold, convex but difficult of determination, and one was flat; none were concave. We examined 16 femora of the gorilla; of these four were sensibly convex; four were slightly but not markedly convex; two were actually convex but looked flat to the eye; two were actually flat; two were just on the concave side of flatness, and the remaining two very slightly but appreciably concave. Thus while concavity does not occur in the orang and chimpanzee femora examined by us, we found it in a not marked form in 25 % of the gorilla femora. Turning to the human femora we determined the curvature in the London series of nearly 800 cases[1] and found:

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[1] We have not investigated the transverse as distinct from the sagittal bowing of our bones, as it appeared to us almost impossible to measure it adequately. The only statistical data we know of on this point are those due to Bumüller (Bibl. 81, S. 44) who states that in 246 femora he found lateral transverse bowing in 27 cases and mesial transverse bowing in 20 cases. He does not, however, state how he appreciated the presence and absence of this bowing. His discussion of the subject is slender and not convincing.

[2] In his paper of 1896 Dubois again emphasises the rounded popliteal surface as the only difference between the Trinil and a human femur. He says that the "Art Wulst" which occurs (exactly as in our L. S. 46 !) appears also in the gibbon and suggests that when it does occur, as rarely in man, it may well be associated with "eine affenähnliche Muskelvarietät." Bibl. 70 *bis*, S. 19.

[3] As a rule the convexity or concavity can be judged at once by sight or touch. In nearly flat cases it is best to press a thin plane strip of metal against the surface and see which way its terminals move.

Curvature Percentages.

	Convex	Flat	Concave
Male Right	51·5 %	13·3 %	35·2 %
Male Left	48·8 %	23·8 %	27·4 %
Female Right ...	31·7 %	16·1 %	52·2 %
Female Left ...	34·5 %	22·2 %	43·3 %

Now this table appears to us somewhat noteworthy: the general impression that the popliteal surface in man is concave is not confirmed. Among males about 50 % have their femora convex, only a little over 30 % are concave; among females the reverse numbers roughly hold, about 50 % are concave and a little over 30 % are convex. It is not possible to speak of concavity as the rule in the human femur. Further concavity seems a secondary sexual character, being much more marked in the female, while there is some evidence to show that the left bone is in respect of concavity "more male than the right." Those who believe that "muscle moulds form" will see no doubt in the more apelike popliteal surface of the male some product of greater musculature. All we should suggest would be that the more apelike form of the male is certainly associated with greater muscular development.

We are now in a position to consider how far the popliteal indices can achieve the principal purposes for which they were designed. It will be remembered that they were introduced by Manouvrier as a means of quantitatively comparing the popliteal area of the Trinil femur with those of the apes, of palaeolithic man and of recent man. From this standpoint considerable stress has been laid on the relative magnitude of the direct[2] and the oblique antero-posterior popliteal diameters, the *mp* and *mn* of our Diagrams *C* (Plate II) and *E* (Plate III). We have already shown that the relative magnitude of *mp* and *mn* in individual cases will form no true measure of the convexity and concavity of the popliteal surface (see our p. 15), but we have yet to investigate whether in the mass of the population there is any relation between concavity and our secondary popliteal index, *i.e.* 100 × ratio of direct to oblique antero-posterior diameter. We have formed four correlation tables connecting this secondary popliteal index with the popliteal curvature.

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[1] Bumüller (Bibl. 81, S. 65) gives for 193 Bavarian femora: convex, 29·0 %; flat, 48·2 %; concave, 22·8 %. He has clearly put far more into the flat category than a mathematician would do, and accordingly we do not think the numbers point necessarily to a racial difference.

[2] The term "direct" is convenient but not wholly adequate; *mp* is often itself very oblique to the sagittal plane of the femur.

Correlation of Index of Popliteal Skewness with Popliteal Curvature.

Value of Index of Popliteal Skewness.

Sex and Side	Curvature	78*	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	Totals	Means of Arrays
Male Right	Concave	—	—	—	1	—	1	5	1	6	8	8	5	14	5	9	7	5	1	3	—	2	81	90·24
	Flat	—	—	—	—	—	1	—	—	3	3	4	—	3	3	1	3	1	1	7	—	—	30	91·42
	Convex	—	—	1	—	1	1	3	5	6	3	5	14	11	17	8	12	6	9	9	—	3	114	91·25
	Totals	0	0	1	1	1	3	8	6	15	14	17	19	28	25	18	22	12	11	19	—	5	225	—
Male Left	Concave	1	1	—	—	1	—	1	5	3	5	14	3	5	6	5	7	2	2	1	1	—	63	89·62
	Flat	—	1	—	1	1	—	—	1	3	1	5	6	4	6	8	6	6	4	2	1	—	56	90·96
	Convex	—	—	—	1	1	1	3	3	2	8	9	7	10	17	8	12	8	8	6	2	7	113	93·35
	Totals	1	2	0	2	3	1	4	9	8	14	28	16	19	29	21	25	16	14	9	4	7	232	—
Female Right	Concave	—	—	—	—	1	2	6	7	14	5	11	8	12	7	7	2	4	1	4	1	—	92	89·20
	Flat	—	—	1	—	1	1	—	1	—	1	2	2	3	4	2	3	2	2	3	—	—	28	90·95
	Convex	—	—	—	—	1	2	—	1	4	3	5	1	7	3	4	6	10	1	5	1	2	56	91·59
	Totals	0	0	1	0	3	5	6	9	18	9	18	11	22	14	13	11	16	4	12	2	2	176	—
Female Left	Concave	—	—	—	—	1	—	3	5	4	13	6	6	10	4	13	3	9	1	—	—	2	80	90·10
	Flat	—	—	1	2	1	—	3	1	2	1	1	2	4	4	7	1	3	2	2	2	2	41	90·72
	Convex	—	—	2	—	—	—	1	—	2	1	7	6	5	3	11	1	8	4	7	—	4	62	92·01
	Totals	0	0	3	2	2	0	7	6	8	15	14	14	19	11	31	5	20	7	9	2	8	183	—

* 78— stands for group from 77·95 to 78·95, centre at 78·45; the indices were tabled to one decimal place only.

Examining the means of the arrays it will be seen that with the not very marked exception of male right the secondary mean index increases from concave to flat and again from flat to convex. But the increases though quite sensible are never very great, two to three points at most. Thus the correlation between the index of popliteal skewness and the curvature of the popliteal surface cannot be more than very moderate, so small in fact that as the tables themselves show it would not be possible to predict from the index whether the bone was convex or not. To illustrate this point we have formed two biserial tables for ♂, R. + L. and ♀, R. + L., the divisions being concave and not concave (*i.e.* flat or convex).

Value of Index of Popliteal Skewness.

Sex	Curvature	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	Totals
♂ R. + L.	Concave	1	1	—	1	1	1	6	6	9	13	22	8	19	11	14	14	7	3	4	1	2	144
	Not Concave	—	1	1	2	3	3	6	9	14	15	23	27	28	43	25	33	21	22	24	3	10	313
	Totals	1	2	1	3	4	4	12	15	23	28	45	35	47	54	39	47	28	25	28	4	12	457
♀ R. + L.	Concave	—	—	—	—	2	2	9	12	18	18	17	14	22	11	20	5	13	2	4	1	2	172
	Not Concave	—	—	4	2	3	3	4	3	8	6	15	11	19	14	24	11	23	9	17	3	8	187
	Totals	0	0	4	2	5	5	13	15	26	24	32	25	41	25	44	16	36	11	21	4	10	359

The correlations found by the biserial method are:

♂ (R. + L.), $r = + {\cdot}2300 \pm {\cdot}0396$; ♀ (R. + L.), $r = + {\cdot}2920 \pm {\cdot}0416$.

These are quite significant, but only moderate in intensity. We conclude therefore that the direct and oblique antero-posterior popliteal diameters are unlikely by their relative size to throw much light on popliteal curvature.

We next proceeded to consider how far the primary popliteal index, *i.e.* 100 × ratio of antero-posterior popliteal diameter to popliteal width, is related to popliteal curvature.

CORRELATION OF PRIMARY POPLITEAL INDEX AND POPLITEAL CURVATURE.

Value of Primary Popliteal Index.

Sex and Side	Curvature	49·5 — 52·5	52·5 — 55·5	55·5 — 58·5	58·5 — 61·5	61·5 — 64·5	64·5 — 67·5	67·5 — 70·5	70·5 — 73·5	73·5 — 76·5	76·5 — 79·5	79·5 — 82·5	82·5 — 85·5	85·5 — 88·5	88·5 — 91·5	91·5 — 94·5	Totals	Means of Arrays
Male Right	Concave	1	—	3	9·5	6·5	18	19	10	8	2·5	2	0·5	—	—	—	80	67·78
	Flat	—	—	—	1·5	1·5	6	8	4	2	3	3	1	—	—	—	30	71·05
	Convex	—	—	—	1	8·5	13·5	24	14	20	18·5	9·5	1·5	0·5	2	—	113	72·68
	Totals	1	0	3	12	16·5	37·5	51	28	30	24	14·5	3	0·5	2	0	223	—
Male Left	Concave	1	1	3	5·5	8·5	14·5	11·5	8	2	3	2	2·5	0·5	—	—	63	67·74
	Flat	—	—	1	3	5	9	8·5	10·5	12·5	3·5	2	1	—	—	—	56	70·45
	Convex	—	1	—	1	5	9	19	21·5	21	22·5	9	3	1	—	—	113	73·27
	Totals	1	2	4	9·5	18·5	32·5	39	40	35·5	29	13	6·5	1·5	0	0	232	—
Female Right	Concave	—	—	8	13	21	21·5	16·5	7·5	3·5	1	—	1	—	—	—	93	65·39
	Flat	—	1	—	2	7	6	5	5	1	1	—	—	—	—	—	28	66·75
	Convex	—	—	2	1	8	7·5	12·5	9	9·5	4·5	—	1	1	—	—	56	69·96
	Totals	0	1	10	16	36	35	34	21·5	14	6·5	0	2	1	0	0	177	—
Female Left	Concave	—	—	3	8	17	22	14	9·5	3·5	—	2·5	0·5	—	—	—	80	66·64
	Flat	—	—	—	6	5	9	5	2	10	2	2	—	—	—	—	41	68·93
	Convex	—	—	—	2	3	11	11	14·5	9	5·5	5	—	—	—	1	62	71·61
	Totals	0	0	3	16	25	42	30	26	22·5	7·5	9·5	0·5	0	0	1	183	—

Here without exception there is a continuous and steady rise in the value of the mean primary popliteal index as we pass from concave to flat and flat to convex popliteal areas. Combining as before right and left bones to form two biserial tables we have:

Value of Primary Popliteal Index.

Sex	Curvature	49·5 — 52·5	52·5 — 55·5	55·5 — 58·5	58·5 — 61·5	61·5 — 64·5	64·5 — 67·5	67·5 — 70·5	70·5 — 73·5	73·5 — 76·5	76·5 — 79·5	79·5 — 82·5	82·5 — 85·5	85·5 — 88·5	88·5 — 91·5	91·5 — 94·5	Totals
♂ R. + L.	Concave	2	1	6	15	15	32·5	30·5	18	10	5·5	4	3	0·5	—	—	143
	Not Concave	—	1	1	6·5	20	37·5	59·5	50	55·5	47·5	23·5	6·5	1·5	2	—	312
	Totals	2	2	7	21·5	35	70	90	68	65·5	53	27·5	9·5	2	2	0	455
♀ R. + L.	Concave	—	—	11	21	38	43·5	30·5	17	7	1	2·5	1·5	—	—	—	173
	Not Concave	—	1	2	11	23	33·5	33·5	30·5	29·5	13	7	1	1	0	1	187
	Totals	0	1	13	32	61	77	64	47·5	36·5	14	9·5	2·5	1	0	0	360

The biserial correlations are:

$$♂,\ r = +\cdot4358 \pm \cdot0354; \quad ♀,\ r = +\cdot4059 \pm \cdot0387.$$

There is thus a quite significant and substantial correlation between curvature of the popliteal surface and the customary popliteal index[1]. This correlation is nearly double that of the secondary popliteal index; or, *the popliteal index is a very much better guide to the pithecoid character of the popliteal surface than the relative dimensions of the direct and oblique antero-posterior popliteal diameters.*

Assuming, which is fairly accurate, that marked convexity of the popliteal surface is more ape-like than man-like, in the first place we may consider an index which marks in a certain manner the gracility of the human femur, namely the second transverse index of the shaft or the ratio of 100 pilastric transverse diameter to popliteal width. This index will be nearer 100 in the ape than in man, although in individual human cases it can approach this value. We should therefore anticipate that concavity may be associated with a low value of this gracility index. The tables are given below. An inspection of the means of the arrays shows in the case of both right and left male bones increase of the gracility index (decreased gracility) as we pass from concave to flat and flat to convex bones; the total increase, however, is less than two points. The flat bones are anomalous in the case of the female femora, but in both cases of right and left, the concave bones are more gracile than the convex[2].

CORRELATION OF INDEX OF DISTAL GRACILITY AND POPLITEAL CURVATURE.

Value of Index of Gracility.

Sex and Side	Curvature	52*—	54—	56—	58—	60—	62—	64—	66—	68—	70—	72—	74—	76—	78—	80—	82—	84—	86—	88—	90—	92—	94—	Totals	Means of Arrays
Male Right	Concave	—	—	—	1	6	12	8	7	10	9	7	10	5	3	3	—	—	—	—	—	1	—	82	69·97
	Flat	—	—	—	—	3	2	3	3	2	7	4	3	1	—	—	—	1	1	—	—	1	—	31	70·89
	Convex	—	—	—	4	4	7	10	10	9	13	17	9	16	4	2	2	4	1	1	—	—	—	113	71·57
	Totals	0	0	0	5	13	21	21	20	21	29	28	22	22	7	5	2	5	2	1	0	2	0	226	—
Male Left	Concave	1	—	—	2	1	6	5	8	5	9	9	7	6	1	1	1	—	2	—	—	—	—	64	70·51
	Flat	—	2	—	—	2	4	6	4	5	8	5	12	8	3	2	—	—	1	—	—	—	—	62	71·27
	Convex	—	—	1	2	4	8	5	7	15	15	15	4	9	11	2	4	3	1	—	1	—	—	107	71·92
	Totals	1	2	1	4	7	18	16	19	25	32	29	23	23	15	5	5	3	4	0	1	0	0	233	—
Female Right	Concave	2	—	—	3	2	11	9	11	8	15	11	10	6	1	1	1	—	1	1	—	—	—	93	69·53
	Flat	—	—	—	1	1	2	4	3	5	4	4	2	1	—	1	—	—	—	—	—	—	—	28	69·09
	Convex	—	—	1	—	1	8	7	5	4	8	10	2	4	1	1	2	1	—	—	1	—	—	56	70·41
	Totals	2	0	1	4	4	21	20	19	17	27	25	14	11	2	3	3	1	1	1	1	0	0	177	—
Female Left	Concave	—	1	—	1	3	5	9	7	8	14	8	7	9	1	4	1	1	1	—	—	—	—	80	70·85
	Flat	—	—	—	1	1	—	6	4	2	4	9	4	1	2	1	2	1	1	—	1	—	1	41	72·13
	Convex	—	—	—	—	3	4	2	10	6	9	3	5	6	4	4	1	1	—	1	—	—	1	60	71·70
	Totals	0	1	0	2	7	9	17	21	16	27	20	16	16	7	9	4	3	2	1	1	0	2	181	—

* 52— connotes 51·95—52·95.

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[1] Bumüller (Bibl. 81, S. 65) gives results for 53 Bavarian bones only:

Mean Popliteal Index: Convex (18), 82·2; flat (20), 75·4; concave (15), 80·1,

and argues from this that "flat" is not intermediate between convex and concave. Our results on far ampler material show, however, an orderly sequence and it appears unnecessary to discuss his explanations of a result based on such slender numbers.

[2] Bumüller (Bibl. 81, S. 66) gives the means of what he terms the "transversal index" for a few convex, concave and flat bones. This index is the inverse of our Index of Distal Gracility. In our notation he obtains: Convex, 68·8; flat, 66·7; concave, 66·3.

These results are in the same sense as ours indicating increased gracility with concavity.

Using biserial tables, the two categories being concave and not concave, we find:

♂ (R. + L.), $r = +\cdot 1413 \pm \cdot 0415$; ♀ (R. + L.), $r = +\cdot 1148 \pm \cdot 0442$.

Accordingly judging from the second transverse shaft index gracility is significantly, but only very slightly, associated with a concave popliteal surface.

The following are the biserial tables deduced from the above adding together right and left members:

Value of Index of Distal Gracility.

Sex	Curvature	52*—	54—	56—	58—	60—	62—	64—	66—	68—	70—	72—	74—	76—	78—	80—	82—	84—	86—	88—	90—	92—	94—	Totals
♂ R. + L.	Concave	1	—	—	3	7	18	13	15	15	18	16	17	11	4	4	1	—	2	—	—	1	—	146
	Not Concave	—	2	1	6	13	21	24	24	31	43	41	28	34	18	6	6	8	4	1	1	1	—	313
	Totals	1	2	1	9	20	39	37	39	46	61	57	45	45	22	10	7	8	6	1	1	2	—	459
♀ R. + L.	Concave	2	1	—	4	5	16	18	18	16	29	19	17	15	2	5	2	1	2	1	—	—	—	173
	Not Concave	—	—	1	2	6	14	19	22	17	25	26	13	12	7	7	5	3	1	1	2	—	2	185
	Totals	2	1	1	6	11	30	37	40	33	54	45	30	27	9	12	7	4	3	2	2	—	2	358

* 52— connotes 51·95—53·95.

Two further indices bearing on the popliteal surface have also been correlated by us with the popliteal curvature. The first of these is the soffit index or 100 × ratio of popliteal width to bicondylar width. It has been suggested that the sudden narrowing in above the condyles may be a differential mark between the Neanderthal type and *Pithecanthropus*: see Fig. 2, p. 10 above. Somewhat akin to this point is the "Eifel Tower" form or pyramidal structure of the lower third of the femur in man. We have endeavoured to measure this also so-called "trumpet" form by our second, the pyramidal index, *i.e.* 100 × ratio of popliteal width to popliteal length. The tables on the following page were obtained for these two correlations.

The results for the soffit index and the curvature are singularly consistent; there is a quite definite if not very large correlation between concavity and a high value of the index. The means all run one way, and the convex or more apelike femora have a narrower popliteal surface relative to the bicondylar width. The *Pithecanthropus* soffit index is 46·2 which is well within the range of modern man (although the mean of the latter is about 50·00[1]), and is hardly differentiated from the Neanderthal femur at 45·3. The order of means is:

	♂ (R. + L.)	♀ (R. + L.)
Concave	51·07	51·60
Flat	50·23	51·30
Convex	49·67	49·07
Correlation of Concavity and high Index	$+\cdot 2450 \pm \cdot 0476$	$+\cdot 2579 \pm \cdot 0562$

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[1] If we take the values of the indices for *Pithecanthropus* and Neanderthal from Klaatsch's contour drawing (p. 10) we have 50·96 and 36·59! His "modern man" seems to be unfortunately selected; it gives an index of 43·18, which according to our experience is far from the type value for the human femur. Hepburn's data give 50·14 for British, in excellent agreement with ours; 43 is a value of the soffit index

Correlation of Curvature and Soffit Index.

Soffit Index.

Sex	Curvature	37*—	38—	39—	40—	41—	42—	43—	44—	45—	46—	47—	48—	49—	50—	51—	52—
♂ R. + L.	Concave	—	1	1	—	1	1	3	2	3	9	5	7	8	9	7	12
	Flat	—	—	—	—	—	2	1	4	5	6	2	3	3	8	9	2
	Convex	1	—	—	2	1	4	4	4	15	11	15	15	11	17	10	6
	Totals	1	1	1	2	2	7	8	10	23	26	22	25	22	34	26	20
♀ R. + L.	Concave	—	—	—	—	—	1	1	2	1	7	6	4	7	12	10	12
	Flat	—	—	1	—	—	2	—	—	1	1	5	3	2	5	3	4
	Convex	1	—	—	1	—	1	1	5	4	8	5	4	1	13	8	4
	Totals	1	0	1	1	0	4	2	7	6	16	16	11	10	30	21	20

Sex	Curvature	53—	54—	55—	56—	57—	58—	59—	60—	61—	62—	63—	64—	65—	66—	67—	Totals
♂ R. + L.	Concave	8	7	4	5	2	4	1	2	—	—	—	—	—	—	1	103
	Flat	7	5	3	2	1	—	1	—	—	—	—	—	—	—	—	64
	Convex	7	4	6	3	—	1	1	—	—	—	—	—	—	—	—	138
	Totals	22	16	13	10	3	5	3	2	0	0	0	0	0	0	1	305
♀ R. + L.	Concave	13	9	3	5	2	2	—	—	1	1	—	—	—	—	—	99
	Flat	—	4	3	2	—	2	—	—	1	1	—	—	—	—	—	40
	Convex	4	2	1	2	—	—	—	—	—	—	—	—	—	—	—	65
	Totals	17	15	7	9	2	4	0	0	2	2	0	0	0	0	0	204

* 37— stands for 36·95 to 37·95.

It will be seen that the association of concavity with a high index in the individuals of the race, is in accordance with an evolution from Neanderthal type to the modern femur. It is in the same accordance with the difference between *Pithecanthropus* and the modern femur. But we have to remark here that the soffit index for the Trinil femur is really not accurately known, and the question whether the "Art Wulst" is typical or anomalous has not yet been really settled.

We now turn to the pyramidal popliteal index, of which the correlation with the curvature is provided in the following table.

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corresponding to Andamans, Negroes or Australian natives. Measured on Dubois' photographs we find the index for *Pithecanthropus* 46·2 rather than the 51·0 of Klaatsch's diagram, and the cast of the Neanderthal femur gives the value 45·3, close to 45·8 which we find as the Neanderthal type mean. Exact measurements of the Trinil femur are here as usual urgently necessary.

CORRELATION OF CURVATURE WITH PYRAMIDAL POPLITEAL INDEX.

Pyramidal Popliteal Index.

Sex	Curvature	21*—	22—	23—	24—	25—	26—	27—	28—	29—	30—	31—	32—	33—	34—
♂ R. + L.	Concave	—	—	—	1	6	3	6	9	10	9	9	17	12	13
	Flat	—	—	1	—	—	2	8	6	7	7	6	12	6	7
	Convex	1	—	2	2	8	8	9	22	12	17	24	19	16	15
	Totals	1	0	3	3	14	13	23	37	29	33	39	48	34	35
♀ R. + L.	Concave	—	1	1	1	7	8	12	6	21	14	14	13	10	15
	Flat	1	1	—	—	2	2	1	6	9	6	8	3	2	6
	Convex	1	—	—	3	1	3	3	9	5	15	7	12	11	12
	Totals	2	2	1	4	10	13	16	21	35	35	29	28	23	33

Sex	Curvature	35—	36—	37—	38—	39—	40—	41—	42—	43—	44—	45—	46—	47—	48—	Totals
♂ R. + L.	Concave	13	7	6	8	4	2	1	3	1	1	2	—	1	—	144
	Flat	5	2	6	1	4	2	2	1	—	—	—	—	—	1	86
	Convex	9	15	5	15	9	7	3	2	1	1	1	—	—	—	223
	Totals	27	24	17	24	17	11	6	6	2	2	3	0	1	1	453
♀ R. + L.	Concave	10	7	4	5	10	2	3	1	4	—	1	—	—	—	170
	Flat	4	4	—	4	1	4	1	2	1	—	1	—	—	—	69
	Convex	4	5	2	8	5	3	4	—	1	—	—	—	—	1	115
	Totals	18	16	6	17	16	9	8	3	6	0	2	0	0	1	354

* 21— signifies 20·95 to 21·95.

The correlations as in the previous tables were found by the biserial method dividing into concave and not concave. The following values resulted:

Values of Means of Pyramidal Indices for Arrays.

	♂ (R. + L.)	♀ (R. + L.)
Concave	33·42	32·54
Flat	32·93	32·96
Convex	32·78	33·18
Correlation of Curvature and high Index	+ ·0794 ± ·0411	– ·0744 ± ·0448

The means run smoothly, but in opposite senses for the two sexes. Hence there may be significant sexual difference in the relationship of curvature and pyramidal index, a long trumpet shape being associated with convexity in the male and concavity in the female. The correlations, however, are so small that there is possibly no relationship whatever between these characters.

Lastly we thought it worth investigating whether the curvature of the popliteal surface was connected with (i) a marked feature of man's upward progress and (ii) a human anomaly which characterises his relation to lower forms. As our first variate we selected the band-radial index; as our second the presence of the third trochanter. The great difference in tension of femoro-fibular ligament, when the upper and lower members of the leg are straight or bent, has been attributed largely to the difference between the vertical and horizontal "band-radii" of the external condyle. The area of attachment of this ligament can be clearly seen in Diagram E (Plate III) and the general excess of the vertical over the horizontal radius is indicated, although it is difficult of exact measurement. The upright position of man has been closely associated with the band-radial index = 100 vertical band-radius/horizontal band-radius. We should accordingly consider, if man's upright position be associated with the band-radial index and convexity with the ape, that convexity would be correlated negatively and substantially with the magnitude of the band-radial index. It will be seen by examining the

Correlation of Band-radial Index and Popliteal Curvature[1].

Value of Band-radial Index.

Sex and Side	Curvature	81*—	84—	87—	90—	93—	96—	99—	102—	105—	108—	111—	114—	117—	120—	123—	126—	129—	132—	135—	138—	141—	144—	Totals	Means of Arrays
Male Right	Concave	—	1	—	1	3	—	3	4	5	10	5	4	6	4	2	2	1	—	1	1	1	1	55	113·10
	Flat	—	—	—	—	2	1	4	—	2	5	1	1	4	1	1	1	—	—	—	—	—	—	23	109·71
	Convex	1	1	—	2	3	1	5	6	11	7	10	5	6	8	5	—	1	2	1	3	2	—	80.	112·94
	Totals	1	2	0	3	8	2	12	10	18	22	16	10	16	13	8	3	2	2	2	4	3	1	158	—
Male Left	Concave	—	—	—	—	1	5	8	7	7	7	4	3	2	2	—	3	4	—	1	—	—	—	54	109·95
	Flat	—	—	—	1	1	2	6	3	2	7	3	3	1	2	4	1	1	—	—	1	2	—	40	112·45
	Convex	—	—	3	2	4	8	7	10	9	8	7	8	5	5	1	3	3	—	—	—	—	—	83	108·26
	Totals	0	0	3	3	6	15	21	20	18	22	14	14	8	9	5	7	8	0	1	1	2	0	177	—
Female Right	Concave	—	—	1	—	1	2	6	4	10	5	5	8	8	4	2	3	—	—	1	1	1	—	62	112·50
	Flat	—	—	—	1	—	1	—	1	3	2	1	1	3	—	1	—	1	—	—	—	—	—	15	111·25
	Convex	—	—	—	1	3	1	—	2	8	4	4	1	5	1	1	1	—	2	—	—	1	—	35	111·68
	Totals	0	0	1	2	4	4	6	7	21	11	10	10	16	5	4	4	1	2	1	1	2	0	112	—
Female Left	Concave	—	—	1	1	1	2	1	4	4	10	6	3	4	4	—	—	—	—	—	2	—	—	43	110·78
	Flat	—	1	—	1	1	4	4	1	—	3	4	5	2	2	1	1	1	—	—	—	—	—	31	109·16
	Convex	—	—	1	2	1	3	3	5	7	2	3	4	2	4	1	1	—	—	1	—	—	—	40	108·78
	Totals	0	1	2	4	3	9	8	10	11	15	13	12	8	10	2	2	1	0	1	2	0	0	114	—

Biserial Table. Values of Band-radial Index.

Sex and Side	Curvature	81*—	84—	87—	90—	93—	96—	99—	102—	105—	108—	111—	114—	117—	120—	123—	126—	129—	132—	135—	138—	141—	144—	Totals
♂ R. + L.	Concave	—	1	—	1	4	5	11	11	12	17	9	7	8	6	2	5	5	—	2	1	1	1	109
	Not Concave	1	1	3	5	10	12	22	19	24	27	21	17	16	16	11	5	5	2	1	4	4	—	226
	Totals	1	2	3	6	14	17	33	30	36	44	30	24	24	22	13	10	10	2	3	5	5	1	335
♀ R. + L.	Concave	—	—	2	1	2	4	7	8	14	15	11	11	12	8	2	3	—	—	1	3	1	—	105
	Not Concave	—	1	1	5	5	9	7	9	18	11	12	11	12	7	4	3	2	2	1	—	1	—	121
	Totals	0	1	3	6	7	13	14	17	32	26	23	22	24	15	6	6	2	2	2	3	2	0	226

* 81— signifies all values from 80·95—83·95, the indices being recorded by units of ·1.

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[1] The paucity of data in this case arises from the frequency with which the epicondyles are too damaged to allow of any determination whatever of the band-radii.

means of arrays that there is only one case—the female left bone—in which the band-radial index decreases regularly, from concave to flat and flat to convex, and then the decrease is only a matter of two points. On the other hand the band-radial index for all four series is greater in the concave than the convex bones, the flat bones—relatively few in number—being anomalous. Such results lead us to expect a very small negative correlation only. This was determined as in the earlier cases and led to the values by the biserial method:

$$♂\ (\text{R.}+\text{L.}),\ r=-\cdot 0387 \pm \cdot 0479\,;\quad ♀\ (\text{R.}+\text{L.}),\ r=-\cdot 1045 \pm \cdot 0558.$$

All we can say is that the correlations are both negative, but that neither are significant having regard to their probable errors. Thus these two apelike characters, convexity of popliteal surface and excess of horizontal band-radius, do not appear in man to be sensibly correlated.

We now turn to our second illustration, the search for any link between the presence of the third trochanter and the convexity of the bone. Here the results appear to us of some singularity. The tables are given below and we deduce the following percentages:

3rd Trochanter	Male Right		Female Right		Male Left		Female Left	
	Concave	Not Concave	Concave	Not Concave	Concave	Not Concave	Concave	Not Concave
Marked	15·38	26·92	17·05	30·26	22·22	18·63	34·21	31·25
Absent	57·69	52·11	50·00	47·37	47·62	49·07	36·84	34·38

Relation of Third Trochanter to Curvature of Popliteal Surface.

Third Trochanter	Male Right				Female Right				Male Left				Female Left			
	Concave	Flat	Convex	Totals	Concave	Flat	Convex	Totals	Concave	Flat	Convex	Totals	Concave	Flat	Convex	Totals
I	2	5	3	10	5	1	4	10	4	0	6	10	7	3	4	14
II	10	4	21	35	10	5	13	28	10	9	15	34	19	9	14	42
III	21	7	28	56	29	7	10	46	19	20	32	71	22	19	14	55
IV	45	15	59	119	44	11	25	80	30	26	53	109	28	8	25	61
Totals	78	31	111	220	88	24	52	164	63	55	106	224	76	39	57	172

It is clear that in the right femur of both male and female there is a very considerable increase of cases with marked third trochanter in the convex bone category. On the other hand this predominance does not occur with the left bones of either sex, where indeed there is a difference—insignificant in itself—the other way round. Nor can we assert that the right bone generally is more primitive than the left, and thus more likely to show association of primitive femoral characters[1]. Without further tests of long series of femora we should hesitate to assert that this anomalous association of convexity of popliteal surface and presence of third trochanter is a reality. All we can draw attention to is the danger of such relationship being screened if we pool right and left members. Thus the correlation as found from the mean square contingency for example of

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[1] Thus examining the table on p. 291 we see that convex bones if somewhat more frequent on male right are less so on female right. Again, marked cases of *trochanter tertius* occur: ♂, R. 20·45 °/ₒ; ♂, L. 19 64 °/ₒ; ♀, R. 23·17 °/ₒ; ♀, L. 32·56 °/ₒ—the only substantial difference being in favour of the female *left* bone.

$$♂\ (\text{R.} + \text{L.}) = \cdot 0555 \text{ and of } ♂\ (\text{R.}) = \cdot 2317,$$

the former being insensible and the latter significant if small.

To sum up our results for curvature, we conclude

(i) That convexity of the popliteal surface is a marked character of the anthropoid apes, but concavity is not in the same sense a marked character of man—certainly not a specific character.

(ii) That there are no strong correlations between convexity of the popliteal surface and what may be considered apelike characters in man for example a low band-radial index, or a pyramidal form of that surface.

(iii) The curvature is, however, substantially related to the primary popliteal index, this latter being a much better guide to the curvature than the secondary popliteal index based on Manouvrier's direct and oblique popliteal antero-posterior diameters.

(iv) After the primary popliteal index, the soffit, or popliteal bicondylar index, is most closely related to the curvature and some considerable way behind this the index of lower or distal gracility of the shaft.

In these three cases the association between the characters intraracially is what we might anticipate from evolutionary development—*i.e.* the more concave the popliteal surface the lower is the popliteal index, the less recedent are the lips of the *linea aspera* on springing from the epicondyles and the more gracile is the shaft.

As far as comparative data for the lower races, primogenial man and the apes are as yet available, they will be found under our discussion of the individual indices or in the second part of this chapter.

IX. *Other Indices of Shaft.*

(*a*) *Indices of Gracility.* The Lower or Distal Index of Gracility is an important measure of the midshaft thinning on which much of the gracility of the human femur depends, and which markedly differentiates human from anthropoid femora. Since the transverse thinning of the shaft is accompanied in the human case by an increased antero-posterior diameter we should anticipate a correlation between gracility and pilastry. Since the index of the former = 100 × pilastric transverse diameter/popliteal width, and the index of the latter = 100 × pilastric antero-posterior diameter/pilastric transverse diameter, any three lengths selected at random would show negative *correlation* in these indices, or a lesser index of gracility (*i.e.* greater gracility) would be associated with greater pilastry. The danger of this spurious correlation being interpreted as organic must be borne in mind. The importance of the index of gracility was impressed upon us when considering Klaatsch's comments on the inadequacy of the popliteal index as a criterion between modern man, primogenial man and the anthropoids: see our pp. 9—10 above.

The following table gives a few values of the Index of Distal Gracility:

TABLE X. *Index of Distal Gracility.*

	No.	Value		No.	Value
Gorilla	4	75·0	Cromagnon	5	72·0
Orang-utan	3	72·8	Tilbury Femur	1	81·2?
Chimpanzee	5	83·3			
Gibbon	3	88·4	Australians	14	77·26
			Maori	15	66·08
Pithecanthropus erectus	1	76·7	"Modern British"	44	66·26
			Eskimo	4	66·45
Neanderthal	1	75·9	Modern Bavarians	32	67·25
Spy	1	69·9	Andamans	12	68·36
Homo mousteriensis (*Hauseri*) ...	1	57·6	17th century Londoners ♂ R.	230	70·74
La Chapelle-aux-Saints ...	1	77·8	♂ L.	239	71·34
Galley Hill	1	58·9	♀ R.	180	69·74
Homo aurignacensis (*Hauseri*) ...	1	72·7	♀ L.	184	71·74
			Negroes	13	72·79

With the exception of our London data the material is of the slenderest, and can only be taken as suggestive. It is all the more important to bear this in mind, as Hepburn has not taken his popliteal section, we think, by absolutely the same methods as ours.

Bumüller uses as his index the ratio popliteal transverse diameter/pilastric transverse diameter, and terms this by the rather inadequate name "transversal index." He measures it only on 32 of his 400 odd Bavarian femora, and without regard to side or sex. Expressed in terms of our index his frequency distribution is:

Index of Gracility	55·6–58·8	58·8–62·5	62·5–66·7	66·7–71·4	71·4–76·9	76·9–83·3	Total
Frequency	3	3	10	9	5	2	32
Mean Pilastric Index	112·6	108·7	104·7	102·7	94·0	91·8	—

which leads to a mean value of 67·25. Underneath each frequency we have placed the corresponding mean value he gives for the pilastric index. Considering that he has merely taken 32 femora, presumably absolutely at random, the graduated change in his pilastric index is a most fortunate if fortuitous result! A consideration of the probable errors of means based on 2, 3 and 5, when the standard deviation of the character is over 6 points, will emphasise the luckiness of the values. It is, however, inconclusive, because as we have already indicated there is spurious correlation involved in the direct correlation of these indices.

Bumüller, it will be remembered (see our p. 228), has discarded all other femoral lengths except the diaphysial length, and he forms an index of the ratio popliteal length to diaphysial length. Our nearest index would be the popliteal shaft index (see p. 39), *i.e.* 100 popliteal length/length of shaft. That index (see Table II, p. 116) indicates that the popliteal length is slightly less than one-third of the shaft length, say ·32[1]. The ratio of popliteal length to trochanteric length lies between

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[1] Actually we find 73 ♂ s ·321 and 62 ♀ s ·320 for our Londoners.

·28 and ·29—also for our Londoners. Accordingly we might have anticipated that Bumüller's index will be about ·30, for his diaphysial length must lie somewhere between our shaft length and trochanteric length. The value we find from Bumüller's slender data, 32 Bavarian femora, is roughly ·34. This agrees with his mid-group value for 19 femora of indices of gracility from 62·5—71·4. Practically all his data[1] are involved in:

Index of Gracility	55·6–62·5	62·5–71·4	71·4–83·3	Total
Frequency	6	19	7	32
Popliteal Length/Diaphysial Length	·32	·34	·36	—

We fear that with due regard to the probable errors this is somewhat slender evidence to base any argument that increased gracility means that the popliteal apex is lowered. Our own results as given later appear, however, to confirm this view. We are by no means clear as to the interpretation Bumüller himself puts upon his figures in the paragraph following their presentation.

We can obtain some appreciation of the correlation between the index of gracility and the popliteal shaft index in the following manner: Let i_1, i_2 represent these indices respectively; let t be the transverse pilastric diameter, l the popliteal length, w the popliteal width and s the shaft length; then

$$r_{i_1 i_2} = \frac{V_2 V_t r_{lt} + V_w V_s r_{ws} - V_2 V_w r_{lw} - V_t V_s r_{st}}{V_{i_1} V_{i_2}}.$$

Now the six coefficients of variation are known from Tables III and IV of pp. 164—5, while r_{lt}, r_{lw} and r_{st} are given in Table I, p. 193. But we have not r_{ws}, the correlation of popliteal width and shaft length. We have, however, the correlation of popliteal *length* and shaft length, which since the former is a part of the latter we should expect to be higher than the correlation of popliteal width and shaft length. The mean value of this correlation for the two sides and two sexes is ·2925, and accordingly we should expect the popliteal width and the shaft length to have a correlation below this. Now the correlation of shaft length with both pilastric transverse and bicondylar width is known, and we again may anticipate that the correlation of shaft length and popliteal width will lie between these two, and might very reasonably be interpolated by a formula of the form:

$$r_{sw} = \frac{r_{st}(b-w) + r_{sb}(w-t)}{b-t},$$

where t, w and b are the pilastric transverse, popliteal and bicondylar widths. It will be found sufficiently approximate to give $(b-w)/(b-t)$ and $(w-t)/(b-t)$ the round values $\frac{3}{4}$ and $\frac{1}{4}$. This leads to the values of r_{sw}:

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[1] Bibl. 81, p. 64. Bumüller's results are given in a manner very difficult of interpretation. He writes: "Die sich hiebei ergebende Länge des Planum popliteum war im Maximum der 2,3 Teil der Diaphysenlänge $= {}^1/_{2,3}$." We presume he means by this the diaphysial length was 2·3 times the popliteal length, but this is hardly what he says. He writes ${}^1/_{2,8}$, ${}^1/_{2,9}$, ${}^1/_{3,1}$ for our ·36, ·34, ·32 respectively. We are, however, far from certain that he does not mean his ratios to be ·28, ·29 and ·31. In which case his mean ·29 would still agree roughly with ours (·32), but his association would be reversed in sign, although his statement of association appears to correspond, as far as we follow it, with ours. Anyhow no reliable results can be based on so few bones.

♂ R. + ·255, ♂ L. + ·215, ♀ R. + ·168, ♀ L. + ·176.

Using these values in the above formula we deduce:

Correlations of Index of Gracility (Lower) and Popliteal Shaft Index.

♂ R. + ·125, ♂ L. + ·041, ♀ R. + ·133, ♀ L. + ·135.

These correlations suffice to indicate that high values of the two indices have a slight positive correlation, the female showing it somewhat more than the male. In other words, in the more gracile bone the popliteal apex will fall rather lower in the shaft. It seems very doubtful whether such inconsiderable associations (which in our case of some 800 bones in four series have probable errors in excess of ·04) could possibly be detected by the examination of 32 femora.

We now return to the problem of the extent to which gracility is associated with pilastry. Our crude correlations taken from Table II, p. 195, are:

Correlations of Index of Distal Gracility and Pilastric Index.

♂ R. – ·397 ± ·038, ♂ L. – ·451 ± ·035, ♀ R. – ·355 ± ·044, ♀ L. – ·513 ± ·037.

The correlations are thus quite substantial and *negative* or the greater the pilaster the more gracile is the bone. But, as we have already remarked, the negative sign and the high values *might* arise solely from the fact that the pilastric transverse diameter occurs in the numerator of one index and the denominator of the other. We therefore asked ourselves the question whether among all the bones with the same pilastric transverse the more gracile have the greater pilaster. In statistical language we calculated the correlation of the two indices for *constant* pilastric transverse.

In order to solve the problem we must find the correlations between the pilastric transverse and the pilastric index and index of gracility. Let i_3 and i_1 represent these indices respectively; let t be the pilastric transverse, a the pilastric antero-posterior diameter, w the popliteal width. Then we can show that to the usual approximation:

$$r_{i_1t}=(V_t-r_{wt}V_w)/V_{i_1} \text{ and } r_{i_3t}=(r_{at}V_a-V_t)/V_{i_3},$$

but V_t, V_w and V_a are given in Table III of p. 164, V_{i_1} and V_{i_3} in Table IV of p. 165, and r_{wt}, r_{at} in Table II of p. 195. Thus r_{i_1t} and r_{i_3t} are found:

Correlations.

	Pilastric Transverse and Index of Distal Gracility	Pilastric Transverse and Pilastric Index
♂ R.	+ ·2998	– ·6008
♂ L.	+ ·3107	– ·5723
♀ R.	+ ·3384	– ·6253
♀ L.	+ ·4631	– ·6163

Substituting these values in the formula

$${}_tr_{i_1i_3}=(r_{i_1i_3}-r_{i_1t}r_{i_3t})/\sqrt{(1-r_{i_1t})(1-r_{i_3t})},$$

we obtain:

Correlations of Index of Distal Gracility and Pilastric Index for Constant Pilastric Transverse.

♂ R. – ·233 ± ·041, ♂ L. – ·350 ± ·038, ♀ R. – ·195 ± ·048, ♀ L. – ·326 ± ·045.

Thus there is a quite significant *negative* correlation, notwithstanding that we make the pilastric transverse constant; only about 30 °/。 of the larger negative values of the total correlation appears to arise from the spurious source. There is therefore a real organic relation between gracility and the occurrence of the pilaster.

Another interesting point arises out of the analysis. It is easy to see that to the same degree of approximation:

$$r_{i_1 i_3} = (V_a V_t r_{at} + V_w V_t r_{wt} - V_t^2 - V_w V_a r_{wa})/(V_{i_1} V_{i_3}).$$

Accordingly:

$$r_{wa} = (V_a V_t r_{at} + V_w V_t r_{wt} - V_t^2 - V_{i_1} V_{i_3} r_{i_1 i_3})/(V_w V_a).$$

But by the equations previously given:

$$V_{i_1} V_{i_3} r_{i_1 t} r_{i_3 t} = V_a V_t r_{at} + V_w V_t r_{wt} - V_t^2 - V_a V_w r_{wt} r_{at}.$$

Hence:

$$r_{wa} - r_{at} r_{wt} = \frac{V_{i_1} V_{i_3}}{V_w V_a} (r_{i_1 t} r_{i_3 t} - r_{i_1 i_3}).$$

Again:

$$1 - r_{i_1 t}^2 = (V_{i_1}^2 - V_t^2 - V_w^2 r_{wt}^2 + 2 r_{wt} V_t V_w)/V_{i_1}^2,$$

and:

$$V_{i_1}^2 = V_t^2 + V_w^2 - 2 r_{wt} V_t V_w,$$

or,

$$1 - r_{i_1 t}^2 = V_w^2 / V_{i_1}^2 \times (1 - r_{wt}^2).$$

Similarly:

$$1 - r_{i_3 t}^2 = V_a^2 / V_{i_3}^2 \times (1 - r_{at}^2).$$

Thus finally:

$$\frac{(r_{wa} - r_{at} r_{wt})}{\sqrt{1 - r_{at}^2}\sqrt{1 - r_{wt}^2}} = (r_{i_1 t} r_{i_3 t} - r_{i_1 i_3})/\sqrt{(1 - r_{i_1 t}^2)(1 - r_{i_3 t}^2)},$$

$${}_t r_{wa} = - {}_t r_{i_1 i_3},$$

or approximately the partial coefficient of correlation of the index of gracility and the pilastric index is the partial correlation of popliteal width and pilastric antero-posterior diameter for constant transverse diameter with the sign changed. In other words, the *organic* relation between increased gracility and increased pilastry is actually based on an increase of popliteal width being associated with an increase of pilastric antero-posterior diameter. It will be seen from an examination of p. 195 that the correlation of popliteal width and pilastric antero-posterior diameter is practically as close as the relation of the pilastric transverse to the antero-posterior diameter of its own section.

Gracility of Shaft and Robusticity of Femur.

We should naturally expect that the more robust a bone, *i.e.* the more gorilloid its character, the less would be its gracility. But such a relation is subject to several considerations, among which we may note: (*a*) a doubt as to the fitness with which our measuremental functions have been selected to represent the conceptions of gracility and robusticity, (*b*) the possibility that the functions selected are by their essential nature correlated (*i.e.* spurious correlation) and therefore that the ideas of gracility and robusticity are in themselves associated independently of any organic connection, and alternately (*c*) whether the atmospheres attaching to the words "gracility" and "robusticity" do not create in themselves a *nexus*, which may not be justified by any scientific definition of the "gracile" and "robust" characters.

The reader will remember that we have adopted the French definition of robusticity, *i.e.* the sum of the diameters of the pilastric section divided by the oblique length, the index as usual being taken 100 times this ratio. Further our index of gracility is 100 multiplied by the ratio of the pilastric transverse diameter to the popliteal width. Accordingly we see that the pilastric transverse occurs in the numerator of both ratios and if the values of the measurements were picked out from the observation records at random there would still be a positive correlation between the two indices or a negative correlation between gracility and robusticity. Thus there may be a fictitious or spurious correlation between these indices. If we increase the transverse pilastric diameter we increase both indices. On the other hand we could have a very gracile shaft with a low pilastric transverse, but if there were an exaggerated pilaster the robusticity might be very large, *i.e.* it is quite possible to combine gracility with robusticity and this combination is interracially more or less a human characteristic. The femur of recent man has become more gracile than those of the greater anthropoids by the reduction of the pilastric transverse diameter while it has compensated in robusticity for this loss by the development of the pilaster. Thus far our gracility and robusticity measures do not seem badly selected, if we take the precaution of investigating their correlation for constant pilastric transverse. But the very same train of ideas suggests that the actual organic relationship of gracility and robusticity depends on the secondary associations of bicondylar width, oblique length and pilastric antero-posterior diameter with pilastric transverse diameter; yet such secondary associations may be small and are wholly free of any conceptions brought to mind by the atmospheres usage attaches to the words "gracile" and "robust," which are customarily taken as opposites rather than as independent attributes. The "opposites" conception in this case arises from the presence of the pilastric transverse in both measuremental functions and we shall free ourselves from this by the use of partial correlation.

We may approach the problem as follows: Let $i_1 = 100\,t/b$ be the distal index of gracility, $i_2 = 100\,(t+a)/l'$ be the robusticity of the femur, where t, a, b and l' are the pilastric transverse, pilastric antero-posterior diameters, bicondylar width and oblique femoral length respectively. As usual σ, v and r will denote the standard deviation, coefficient of variation and correlation coefficient of the characters indicated by the subscripts. Then the following relations are found at once:

$$r_{i_1t} = (v_t - v_b r_{bt})/v_{i_1},$$

the numerical values of this correlation are given on p. 303,

$$r_{i_2t} = \left(\frac{\sigma_t + \sigma_a r_{at}}{\bar{t} + \bar{a}} - v_{l'} r_{l't}\right)\Big/ v_{i_2}.$$

Here $\bar{t}$ and $\bar{a}$ are given in Table I, p. 115, σ_t, σ_a in Table I, p. 162, r_{at} in Table II, p. 195, $v_{l'}$ in Table III, p. 164, and v_{i_2} in Table IV, p. 165. The only correlation at present not determined is $r_{l't}$, that of pilastric transverse diameter with oblique length of femur. It might probably have been thought sufficiently accurate to take the correlation of the pilastric transverse with the shaft length, but we have actually calculated the values of $r_{l't}$. We find the following results:

Correlation	♂ R.	♂ L.	♀ R.	♀ L.
$r_{i_1 i_2}$*	+ ·356 ±	+ ·135 ±	+ ·379 ±	+ ·421 ±
$r_{i_1 t}$	+ ·300 ±	+ ·311 ±	+ ·338 ±	+ ·463 ±
$r_{l't}$	+ ·299 ±	+ ·360 ±	+ ·194 ±	+ ·178 ±
$r_{i_2 t}$	+ ·563 ±	+ ·515 ±	+ ·610 ±	+ ·634 ±
$_t r_{i_1 i_2}$	+ ·237	− ·031	+ ·232	+ ·186
Length of Shaft and Pilastric Transverse	+ ·193 ± ·043	+ ·164 ± ·043	+ ·121 ± ·051	+ ·108 ± ·050

* The low value of ♂ L. is anomalous, but is almost obvious on the table itself. Separate tables were formed first by pooling right and left members and gave ♂ R. + L. + ·245 ± ·031 and ♀ R. + L. + ·390 ± ·032, which are close to the mean of R. and L. or ·245 and ·400 respectively.

It will be seen that the moderate correlations between the indices of gracility and robusticity are considerably reduced—even rendered negative in the case of male left—when we take them for constant pilastric transverse. The relation of robusticity and gracility is thus not as close as the "atmospheres" accompanying these words suggest. When the common influence of the pilastric transverse is removed there appears to be a considerable differentiation with side, robusticity being more closely associated with gracility in right than in left bones.

It is well known that there is considerable change of gracility with growth in the case of the human femur. Plates LVIII and LIX are arranged to illustrate this change from the fetus to the adult. Unfortunately it was not possible to procure the femur of a child of five years, but our plates show how marked is the change from the fetus at 6 or 7 months (*A*) to the adult (*H*). We had not enough material available to show a really graduated growth change, but a *single* series of measurements give:

Fetus at 6–7 months	51·1	Child at 9 years	46·0
Infant at birth	48·7	Child at 12 years	46·3
Child at 15 months	47·8	Child at 15 years	50·3
Child at 2–5 years	42·1	Adult	72·9

These values would suggest that gracility is much greater in infancy than in the adult, but that it increases from birth to 2 or 3 years of age. No sound conclusion can, however, be based on isolated individuals, especially when we take into consideration the difficulty of fixing the exact position of the measurements to be made in the case of fetal and young bones[1]. The like changes occur in the greater anthropoids but less markedly in the gibbon. We find, if D. L. stands for Diaphysial Length:

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[1] Bumüller has results for what he terms the Lower Transversal Index which amply corroborate (Bibl. 81, SS. 85—7) the above. His Lower Transversal Index is our Index of Distal Gracility. He also gives under the heading "Längen-Dicken Index," an index resembling to some extent the Index of Robusticity of some French writers, *i.e.* 100 Pilastric Circumference/Oblique Length, only Bumüller uses the Diaphysial Length. The terminology is badly chosen. We suggest the names: Primary Index of Robusticity = 100 Sum of Pilastric Diameters/Oblique Length, Secondary Index of Robusticity = 100 Pilastric Circumference/Oblique Length, Tertiary Index of Robusticity = 100 Pilastric Circumference/Diaphysial Length. A fourth index 100 Sum of Pilastric Diameters/Diaphysial Length would be doubtless the best for the fetus and children, because the Oblique Length is not and the Diaphysial Length is easily ascertained, and because the diameters of the pilastric section are more accurately determinable than the circumference. While Bumüller's material shows no definite changes in Pilastric, Platymeric

Gorilla	*Chimpanzee*	*Orang-utan*	*Gibbon*
Infant (D. L. 134) 56·4	Infant (D. L. 141) 57·5	Infant (D. L. 111) 55·4	Young (D. L. 164·5) 82·6
Adult (D. L. 287) 75·0	,, (D. L. 160) 63·8	Adult (D. L. 182) 72·8	Adult (D. L. 170·7) 88·4
	Adult (D. L. 262) 83·3		

The loss of gracility in the human femur is really based upon the cylindrical character of the anterior aspect of the shaft between platymeric and popliteal sections and this feature is far more marked as our illustrations show in the adult than the infant bone. In this respect the fetal bone resembles neither that of the adult anthropoid nor those of the majority of cases of primogenial man where the aspect of the shaft is roughly cylindrical. The appearance of the femur as a strut, whose cross-sections are those of equal resistance, is much more marked in the infantile than in the adult case, and far more marked than in the anthropoid femora. The infantile femur in this respect is more closely allied to that of primitive races like the Andaman or Maori than to that of anthropoid or primogenial man[1]. The reader must not confuse the measure of gracility involved in the index of gracility with the fact that infantile and fetal femora enlarged to the same diaphysial length as the adult bone have larger apparent pilastric transverse diameters. It is difficult to obtain a measure of the shaft length on young femora, but the following indices of transverse slenderness indicate that the index of slenderness decreases or the slenderness increases with age:

Fetus at 6–7 months	9·31	Child at 9 years	7·67
Infant at birth	8·21	Child at 12 years	6·21
Child at 15 months	8·47	Child at 15 years	6·15
Child at 2–5 years	8·16	Adult	6·95

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or Popliteal Indices with growth, the following valuable table indicates the fairly continuous changes in the proportions of the shaft from the fetus to the adult.

Changes of Tertiary Index of Robusticity and Index of Distal Gracility with Growth.

Serial No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Adult
Sex	♂	?	?	♀	♂	?	♀	?	♂	?	?	?	?	?	♂
Stature	200	—	—	366	420	—	540	—	550	c. 880	c. 960	—	—	—	1657
Diaphysial Length	31	50	50	55	58	61	76	76	77	185	206	220	245	255	384·8
Tertiary Index of Robusticity	32·3	30·0	30·0	30·9	31·0	31·1	26·3	25·0	26·0	22·2	23·8	22·5	20·4	20·4	22·8
Index of Gracility (Lower)	42·9	55·6	52·6	45·5	44·4	—	40·6	42·9	46·7	50·0	52·8	48·5	50·0	50·0	67·2
Mean															
Diaphysial Length	50·8						76·3			222·2					384·8
Robusticity	30·9						25·8			21·9					22·8
Gracility	48·2						43·4			50·4					67·2

The fairly continuous fall in robusticity is in keeping with our photographs. Our measurements given above indicate also that in the extremely young and the adult the gracility of the femur is less, reaching its maximum in childhood at 3 or 4 years.

[1] An exception must be made in the case of *Homo mousteriensis* (*Hauseri*) which owing to its small pilastric transverse has a remarkably small index of gracility.

The adult measured in this series was somewhat below the average human adult value, 7·3 to 7·4, so that it is conceivable that the index increases or slenderness decreases between 15 years and the completion of growth. It is in this index of transverse slenderness that the child is closer to the anthropoid or to primogenial man than to the adult, but he is not so in the index of gracility as we have indicated above. Of course nothing in this statement is opposed to the fact that the femora of infant man and infant anthropoids (see Plate XCI) are more alike than those of the adults.

The Index of Proximal or Upper Gracility is the index which corresponds on the upper half of the shaft to that already discussed for the lower half of the shaft in the preceding pages. It is based on the ratio of the pilastric to the platymeric transverse diameter. The following table contains the chief values we have been able to determine.

TABLE XI. *Index of Proximal Gracility.*

Race	No.	Value	Race	No.	Value
Gorilla	7	100·2	Cromagnon	5	79·3
Orang-utan	3	96·5	Tilbury Femur	1	87·0
Chimpanzee	5	97·5			
Gibbon	3	90·7	Maori	39	72·51
			Moriori	9	75·84
Pithecanthropus erectus	1	83·1?	Negroes	13	84·84
			Eskimo	4	85·13
Neanderthal	1	85·1	"Modern British"	44	86·31
Spy	1	82·9	Andamans	12	88·08
La Chapelle-aux-Saints ...	1	83·3	17th century Londoners ♂ R.	236	88·80
Homo mousteriensis (*Hauseri*) ...	1	78·4	♂ L.	247	88·87
Galley Hill	1	73·9	♀ R.	179	88·46
Homo aurignacensis (*Hauseri*) ...	1	84·7	♀ L.	193	88·74
			Australians	14	89·03

Here modern man with the exception of Moriori and Maori separates the apes from primogenial man. On the other hand as far as our slender and somewhat irregular results for infancy and childhood go we see the infantile femur for this character further removed from the ape than the adult femur and finding its nearest equivalent in such primitive races as Moriori and Maori.

Fetus at 6–7 months ...	67·5	Child at 9 years	83·9
Infant at birth	63·9	Child at 12 years	86·4
Child at 15 months	80·0	Child at 15 years	87·0
Child at 2–5 years	75·0	Adult	88·7

It will be of interest to provide these indices of gracility for the young of the anthropoids. We find the same decrease of gracility with age:

Gorilla	*Chimpanzee*	*Orang-utan*	*Gibbon*
Infant (D. L. 134) 84·8	Infant (D. L. 141) 89·0	Infant (D. L. 111) 79·8	Young (D. L. 164·5) 83·8
Adult (D. L. 287) 100·2	,, (D. L. 160) 88·2	Adult (D. L. 182) 96·5	Adult (D. L. 170·7) 90·7
	Adult (D. L. 262) 97·5		

The character we are considering is associated with the curvature of the lateral and mesial faces of the shaft. It is easy to measure the chord on the lateral face as the diaphysial length on this face and take as our index the ratio 100 subtense/chord. The determination of the chord on the mesial side is not so easy, but may be taken from the border of the distal epiphysis to the base of the trochanter minor. With these proposals we find:

	Index of Mesial Curvature	Index of Lateral Curvature	Mean
Fetus at 6–7 months	8·69	3·86	6·28
Infant at birth	6·68	8·94	7·81
Child at 15 months	8·02	5·33	6·68
Child at 2–5 years	6·45	10·08	8·26
Child at 9 years	7·35	5·68	6·51
Child at 12 years	5·77	4·93	5·35
Child at 15 years	7·78	4·81	6·29
Adult	6·31	5·32	5·82

It is clear that the values in the first half of the last column are on the whole greater than in the second half, but the results are too irregular for us to be certain that with ampler data a good graduated system would be reached. Probably the curvatures would have to be measured on the chords from platymeric to popliteal sections to obtain an adequate numerical estimate of the concavity of the lateral and mesial borders, which strikes the eye as such a marked difference between the infantile and adult femora.

(*b*) *Soffit Index.* The Soffit Index has been introduced with a view of measuring the character of primogenial man emphasised by Klaatsch, namely the rapid reduction in transverse diameter following on a massive distal epiphysis. We base the Soffit Index on the ratio of popliteal to bicondylar width. The following table contains such data as we have been able to collect on this point.

TABLE XII. *Soffit Index.*

Race	No.	Value	Race	No.	Value
Gorilla	7	57·1	Cromagnon	5	51·5
Orang-utan	4	51·6	Tilbury Femur	—	—
Chimpanzee	6	51·1			
Gibbon	4	42·2	Andamans	11	43·86
			Australians	14	44·91
Pithecanthropus erectus	1	47·4	Negroes	13	45·11
			Maori	11	48·84
Neanderthal	1	45·3	Eskimo	4	51·48
Spy	1	45·8	"Modern British"	136	49·98
Homo Mousteriensis (*Hauseri*) ...	1	49·8 ?	17th century Londoners ♂ R.	150	49·88
La Chapelle-aux-Saints ...	1	42·9 ?	17th century Londoners ♂ L.	63	50·08
Galley Hill	1	50·9 ??	17th century Londoners ♀ R.	99	50·85
Homo aurignacensis (*Hauseri*) ...	1	45·3	17th century Londoners ♀ L.	111	50·86

We see that as in the case of the index of gracility modern man separates primogenial man from the greater anthropoids.

(*c*) *Popliteal Pyramidal Index.* This index which is based on the ratio of popliteal width to popliteal length is a rough measure of the pyramidal form of the popliteal area. We say "rough" advisedly because the position of the popliteal apex is not capable of very accurate determination, especially in the case of the apes, where we can only treat the apex as the position of nearest approach of the margins of the *linea aspera.* Besides our own measurements on the apes we have only the values deduced from Hepburn's measurements, who takes his popliteal length somewhat differently from ours.

The following table contains the values we have been able to collect.

The data are too slender to provide any very definite conclusions. We believe Hepburn's results must be reduced by 25 °/ₒ to be comparable with ours. It seems then probable that the apes in this character separate modern from primogenial man.

TABLE XIII. *Popliteal Pyramidal Index.*

Race	No.	Value	Race	No.	Value
Gorilla	7	35·6	Cromagnon	—	—
Orang-utan	5	27·7	Tilbury Femur	—	—
Chimpanzee	2	27·9	Andamans	12	26·63
Gibbon	1	13·1?	Australians	14	30·54
Pithecanthropus erectus	1	24·0	17th century Londoners ♂ R.	225	33·41
Neanderthal	1	36·9	♂ L.	237	32·70
Spy	1	39·0	♀ R.	178	32·79
Homo mousteriensis (*Hauseri*) ...	1	32·3	♀ L.	183	32·88
La Chapelle-aux-Saints ...	1	33·3?	Negroes	13	34·08
Galley Hill	1	30·4	Maori	15	39·54
			Eskimo	4	45·37
			"Modern British"	41	42·17

(*d*) *Index of Popliteal Skewness.* The reader may be reminded that Manouvrier introduced the measurement of the direct and oblique popliteal antero-posterior diameters with a view of determining the curvature of the popliteal area and thus throwing light on the apelike character asserted for the Trinil femur—practically on the basis of its popliteal convexity. We have discussed the bearing of the Index of Popliteal Skewness on the convexity of the popliteal surface elsewhere: see pp. 288—291. It is not without interest to examine, as far as our limited material permits, the racial values of this index. For our values we are dependent entirely on Hepburn's and our own measurements. The Index of Popliteal Skewness is 100 × Direct popliteal A.P.D./oblique popliteal A.P.D.[1]

Some explanation of the construction of Table XIV is requisite. We have already indicated that Hepburn's measurements of British femora give measurements of the popliteal diameters and thus of the index of popliteal skewness differing very considerably from ours, the source of this divergence having to be sought in his greater length of bone which throws his popliteal section at a relatively lower level for British

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[1] 100 *mp*/*mn* in Manouvrier and Hepburn's notation.

TABLE XIV. *Index of Popliteal Skewness.*

Race	Index of Popliteal Skewness	Race	Index of Popliteal Skewness
Gibbon	100·4 (3)	Cromagnon	96·2? (1)
Chimpanzee	97·5 (3)	Tilbury	98·4? (1)
Orang-utan	97·5 (5)		
Gorilla	80·8 (7)*	Guanches	100·3 (2!) [107·40]
Dryopithecus rhenanus	88·9 (1)	Bushmen	97·1 (2!) [104·00]
		Laplanders	93·2 (4) [99·73]
Pithecanthropus erectus	"*mn*" appears unknown!	Eskimos	92·7 (4) [99·25]
		Negroes	92·5 (13) [98·97]
		Australians	92·1 (14) [98·63]
		East Indians	92·0 (10) [98·44]
Neanderthal	116·1 (1)	Andamans	91·0 (12) [97·43]
		17th century Londoners	♂ 90·96 (463), ♀ 90·57 (363)
Homo mousteriensis (*Hauseri*)	109·4 (1)	"Modern British"	90·96 (44) [97·38]
Galley Hill	105·1 (1)	Chinese	88·60 (2!) [94·85]
Spy	104·7 (1)	Romano-British	88·37 (8) [94·60]
		Maori	88·09 (15) [94·31]
		Malays	85·0 (2!) [90·95]

* By an oversight in our Table of the "Femora of Primogenial Man and Comparatives" in Chapter X the number is given as 3 instead of 7.

bones: see our p. 124[1]. In the cases of the apes we have followed the 1/10 of the diaphysial length rule. The problem is how to get the best out of Hepburn's data for the purposes of a general comparison. After much consideration we have reduced Hepburn's "British" to our 17th century Londoner males by the reducing factor ·9341. We cannot believe that there is any *substantial* difference between the true index for his "British" and our Londoners. He gives two series of British, one from the dissecting room provides an index of 97·43 (27), and the other presumably from disinterments and probably in many cases belonging to individuals of a much earlier period gives 97·29 (17). The results are in good accordance, and are still quite close, 96·20 (16), if an anomalous femur of the last series be omitted. It seems to us accordingly that Hepburn's 97 corresponds closely to our 91 value for this index. In case however the reader objects to this reduction, we have placed the uncorrected values of the racial indices we have calculated from Hepburn's measurements in square brackets. It will be seen that the sole effect of adopting these square bracket values would be to leave our 17th century Londoners in an anomalous position at the bottom of the list. Whichever series we adopt the main feature is clear: recent man links up with primogenial man of the Neanderthal type through primogenial man of the Cromagnon type. Gorilla excepted, the apes separate primogenial man from modern man; he is closer to the apes than to primogenial man. Galley Hill is again closer to the Neanderthal type than to modern man. Within the range of existing man the Guanches are nearest to the Cromagnon type, then follow Laplanders, Eskimos and Negroes, while the Australians judged by this index have a slightly less concave popliteal surface than modern Europeans. Towards the bottom of the list with the maximum of concavity are Chinese, Maori, and Malays. The numbers dealt with in many of these cases are far too small to give any security for definite conclusions. What seems clear, however, is that Manouvrier's test would indicate that the Index of Popliteal Skewness if large for *Pithecanthropus erectus* would place that femur farther from the ape and nearer to primogenial man. The humour of the situation may be summed up in the phrase that Hamlet is missing from the play; for nobody—with the possible exception of Professor Dubois—knows the value of *mn* for the Trinil femur[1]. The table, however, suffices to illustrate the point so often referred to in the present chapter—there is no continuous evolutionary series *in one sense* from the anthropoid through any type of primogenial man to primitive man and thence to modern European man.

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[1] We are after longer study by no means sure that this is the only source of divergence between Hepburn and ourselves; it is possible that he and we have not measured Manouvrier's 4 cms. from the same point, although we appear to be using the same terms.

(*e*) *Indices of Sagittal Proportions.* Corresponding to our indices of gracility, which are the ratios of *transverse* diameters, we may take indices of *sagittal* or antero-posterior diameters. We may term these the *indices of proximal and distal taper.* Thus the *Index of proximal Taper* = 100 platymeric antero-posterior/pilastric antero-posterior diameter and the Index of distal Taper = 100 popliteal antero-posterior/pilastric antero-posterior diameter[2].

With a very straight pilaster, the index of proximal taper might be a measure of the "carinate" form of the anterior surface, but markedly carinate femora might occur without a low value of this index if the posterior surface of the shaft were also markedly bowed. Thus every carinate femur has not of necessity a low index. The Cromagnon femur has an index of proximal taper, however, of about 75·0 as against the 90·0 of modern Europeans, and the 100 of the apes. At first sight this might be considered another character in which modern man is nearer to the apes than primogenial man, but the Neanderthal femora give 95·2 and the Spy femora 91·8, results in close accord with those for recent man. The table on the following page gives such data as we have been able to collect.

It must be remembered that the *smaller* these indices the larger is the taper. We see that for the English femora the upper and the lower tapering is greater on the right than on the left, and greater in the male than the female. We think the probable source of this is to be sought in a relatively larger pilaster in the male than in the female and on the right side than on the left.

There are very inexplicable irregularities in this table, especially in the case of the anthropoids. In the Gorilla and Gibbon the indices of proximal taper are greater than those of distal taper while for the Orang-utan and the Chimpanzee this relation is reversed and agrees with what appears to be universal in the case of man. This may only be the result of our very inadequate data for the anthropoids, or it may mark a real differentiation deserving fuller study. Turning to the Index of Proximal Taper we see (i) that modern man as represented by the 17th century Londoners is interposed between the apes and primogenial man of Type A, (ii) that Galley Hill and *Homo aurignacensis* (*Hauseri*) appear again as transitional types between primogenial and modern man, (iii) that primogenial man of the Cromagnon type is in this character separated from modern man by the Neanderthal type. On the other hand he approaches closely to various modern primitive races, Andamans, Australians and Maori.

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[1] A request to Professor Dubois to publish with the present memoir a complete system of measurements to be made by him on the Trinil femur, met with the reply that he was preparing a new monograph on the subject. Thus we are still no wiser than we were twenty years ago!

[2] These indices seem to agree with Bumüller's *Oberer Sagittal-Index* and *Unterer Sagittal-Index.* He gives the value of the latter for a number of apes in his Table, S. 112. For 51 Bavarian femora (? side and sex) he finds a mean of 116·6 for the latter (S. 62) and for 217 Bavarian femora a mean of 90·3 for the former (*loc. cit.* S. 41, A, from which the mean can be roughly found).

In the case of the Index of Distal Taper we have even less definite material to rely upon as our values for modern primitive man are nearly all deduced from Hepburn's data, and we have already indicated that his measurement of the popliteal diameter does not agree with ours. We think his values must be reduced about 11·6°/$_{\circ}$ to agree with ours. His actual values of the Index of Distal Taper are: Negroes, 98·43; Andamans, 100·03; Australians, 91·15; Maori, 104·63; Eskimo, 98·84 and

TABLE XV. *Indices of Sagittal Proportions.*

Race	Indices of Taper			
	Proximal		Distal	
	No.	Value	No.	Value
Gibbon	3	100·9	7	96·9
Gorilla	7	100·8	9	91·6
Orang-utan	3	98·8	9	100·7
Chimpanzee	3	98·7	7	100·0
Dryopithecus rhenanus	1	105·3	—	89·9
Pithecanthropus erectus	1	104·0?	1	106·7?*
Neanderthal	1	84·1	1	105·1
Spy	1	83·3	1	109·9
La Chapelle-aux-Saints	1	81·6	1	90·9
Homo mousteriensis (*Hauseri*) ...	1	94·8	1	116·0
Galley Hill	1	90·8	1	118·3
Homo aurignacensis (*Hauseri*) ...	1	89·5	—	—
Cromagnon ...	5	76·8	—	87·3
Tilbury Femur ...	1	74·9	1	85·7?
Maori	40	75·59	15	92·5
Australians ...	14	76·28	14	80·6
Moriori	9	77·17	—	—
Andamans ...	12	78·35	12	88·4
Negroes	13	80·98	13	87·0
Eskimos	4	87·70	4	87·4
"Modern British"	44	89·89	44	95·97
17th century Londoners ♂ R.	236	90·85	228	94·69
17th century Londoners ♂ L.	247	92·93	238	97·20
17th century Londoners ♀ R.	178	91·44	182	93·16
17th century Londoners ♀ L.	193	92·75	188	96·90
Bavarians ...	217	90·31	51	[116·60]†
Negritos	—	—	10	[113·5]†

* Bumüller gives (Bibl. 81, Tabelle S. 112) 96·7 as his *Unterer Sagittal-Index* for the Trinil Femur based on the Dubois plate. His value for 4 gorilla femora is 98·2, considerably higher than ours.

† These measurements are due to Bumüller and are really incomparable and we believe unreliable. He says (Bibl. 81, S. 62) "so wird man selbstverständlich nicht die höchste Stelle des Pilasters als Messpunkt wählen"; on the contrary we are to take the mean antero-posterior diameter of the "Pilaster-region." How this mean is to be found he does not describe. He does, however, say that, if the pilaster be convex posteriorly, it is best to take the *smallest* diameter. It is clear that this change from the usual maximum to the mean or even to a minimum diameter renders all earlier work of no value for comparative purposes, besides which it provides no definite new rule of measurement. We have only included in the above table Bumüller's values as an illustration of the extreme futility that results from the introduction of individual caprice instead of the following of custom in such matters.

"Modern British" 108·57. With these results modified[1] we find that (i) the anthropoids probably separate primogenial man of the Neanderthal type from modern civilised man, (ii) Cromagnon man appears, judging from Hepburn's *modified* values, to be closer to modern primitive than to modern civilised man and is separated by modern civilised man from man of the Neanderthal type, (iii) the Galley Hill femur appears to be not modern but extreme Neanderthal type in this character, most probably owing to its defective pilastric antero-posterior diameter.

In concluding the first part of this chapter we are compelled to admit that our study of these various indices of the shaft does not demonstrate anything like a continuous evolutionary change *in one sense* with the serial order: anthropoids, Neanderthal man, Cromagnon man, primitive modern man, civilised modern man. This defect in serial order may be due to the slenderness of our data, to personal equation in measurement or to want of accurate measurement in many of the noteworthy instances of primogenial man. Still as a whole the suggestion is strong that, while in many features Galley Hill is an intermediate between Neanderthal man and Cromagnon man, there is not an evolution *in one direction only* from the anthropoids to recent man, but with Cromagnon primogenial man culminated in many characters, and has regressed to more apelike values since. Further we note that in most characters of the femur primitive man of to-day is as far removed from primogenial man as modern civilised man; indeed he may be farther removed.

PART II. COMPARISON OF THE FEMUR OF MAN WITH THOSE OF OTHER PRIMATES

I. INTRODUCTORY.

In dealing with the general characteristics of the femur of man and with the properties of the shaft we have a considerable amount of fairly reliable material for other races which can be used for comparative purposes, and to avoid exaggeratedly long tables for the individual characters, it has appeared rather advantageous than otherwise to postpone a detailed comparison of the human femur with those of the lesser primates until the second part of this chapter. On the other hand, for the epiphyses, especially the distal epiphysis, our comparative human material is much more slender, and it is easier to combine into single tables our data for all the primates.

In this section, while still retaining the measurements for individual races of primogenial man, and in some cases for individual femora, we have adopted solely as our representative series for Recent Man our 17th century Londoners, not because the English are an especially representative group, but because we have got our constants on far larger series than is usual, and therefore they have lower probable errors. Furthermore, we have used identical methods for the Londoners and for the other primates, and accordingly the comparison from *Tarsius* to Londoner is far more valid on the ground of homogeneity of method. For this reason we have preferred generally to confine our attention to the values obtained by ourselves for the apes, rather than to increase our series by combining our measurements with those of other investigators, who most frequently have adopted more or less divergent characters, or used more or less divergent methods of measuring those which bear the same name as our characters do. We have, however, frequently cited their results, when it was desirable to confirm any marked anomaly or peculiarity.

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[1] We must remind the reader that we place no stress on these modifications. *Four* Australian femora of our own give: Index of Popliteal Skewness, 98·1; Soffit Index, 50·65; Index of Proximal Gracility, 83·3; Index of Distal Gracility, 65·7; Index of Proximal Taper, 86·1; and Index of Distal Taper, 108·15. These slender results—with the exception of the first—are neither in accord with Hepburn's nor with our modification of his values. The indices of taper are Neanderthaloid.

The separation of this primate section from the rest of this chapter has further fitted better with the evolution of our plan for this memoir, where as we progressed with our preparation of it, we found it more and more needful to extend our studies from the anthropoids to the lesser apes.

II. Comparison of the Absolute Size of the Primates.

In this section we shall deal with the absolute size of the femur in the various genera of the primates, taking three typical measurements, the maximum length, the trochanteric length, and the diaphysial length, into consideration. The relative size of the chief primates is so obvious at sight that it is only the finer relations which need be dwelt upon in the following discussion.

Beyond the absolute size as measured by the major lengths something may also result from a consideration of the absolute dimensions of the antero-posterior and transverse diameters of the shaft at the three principal cross-sections. We shall accordingly deal with these in order to throw light on the manner in which the increasing robusticity of the shaft has been gained in the upward ascent of the primates.

We shall start first with a comparison of some of the major lengths.

(*a*) *Maximum Length, Trochanteric Length and Diaphysial Length of Primate Femur.*

The table on the following page gives our comparative data.

Here, as in other cases of absolute size (*e.g.* the Proximal Breadth), it seems desirable to divide the Lemuroidea into two groups, one the smaller Lemuroids with *Tarsius* as type, the other the larger Lemuroids with the true Lemurs as type. The noteworthy point about these two groups is that while in the Tarsiidean group the Trochanteric Length is less than the Maximum Length, in the Lemurine group it is greater[1].

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[1] It may be asked how the maximum length can possibly be less than any other length. The answer lies in the definition of the maximum length as the greatest distance between a point on the head and a point on the *mesial* condyle. Even if we extended this definition and took a length from a point on the head to a point on *either* condyle, we should find in certain cases this wider maximum length less than the trochanteric length, owing to the height of the trochanter above the head. If the maximum length of the femur were defined as the maximum length without regard to start or finish, in certain apes it would lie between the top of the great trochanter and the mesial condyle. This would be neither the more narrowly defined maximum length nor the trochanteric length, but the maximum trochanteric length. This is the case with the *Lemurinae* and with all the *Simiadae*. We have not seen this point referred to by any femoralogist, but it is clear that the so-called *maximum* femoral length was fixed owing to the anthropologist regarding man only, and not heeding the problems of comparative femoralogy.

TABLE XVI. *Maximum Length, Trochanteric Length and Diaphysial Length of Femora of Primates.*

	Group	Maximum Length		Trochanteric Length		Diaphysial Length	
Lemuroidea	*Galaginae* (6)	61·2	Mean 67·38 Mean 101·25	60·8	Mean 66·70 Mean 101·64	51·5	Mean 57·57 Mean 88·10
	Tarsiidae (2)	64·2		63·9		55·5	
	Lorisinae (6)	76·75		75·4		65·7	
	Chiromyrdae (2)	124·65	Mean 135·12	123·75	Mean 136·58	109·65	Mean 118·63
	Lemurinae (18)	129·0		131·6		110·3	
	Indrisinae (8)	151·7		154·4		135·95	
Cebidae	*Hapalinae* (16)	65·9	Mean 130·77	66·0	Mean 128·89	57·0	Mean 113·03
	Nyctipithecinae (8)	88·8		87·9		77·8	
	Lagothrix (2)	112·0		110·0		94·7	
	Cebus (6)	119·5		119·2		103·7	
	Pithecia (2)	129·6		127·3		115·05	
	Mycetes (2)	151·65		148·75		130·65	
	Brachyurus (2)	155·2		153·9		137·15	
	Ateles (4)	223·5		218·1		188·2	
Simiadae	*Cercopithecus* (8)	142·1	Mean 192·97	144·0	Mean 195·87	123·4	Mean 167·58
	Macacus (14)	173·3		175·6		149·3	
	Semnopithecus (10)	200·6		202·7		174·5	
	Cercocebus (4)	219·95		222·85		191·6	
	Cynocephalus (8)	228·9		234·2		199·1	
	Dryopithecus rhenanus (1) ...	287·0		284·2		255·9	
Simiinae	Gibbon (2)	193·55		192·2		170·7	
	Orang (5)	236·7	Mean 298·05	219·2	Mean 291·00	182·2	Mean 243·02
	Chimpanzee (2)	314·55		311·0		261·8	
	Gorilla (4)	♂ 368·35	342·91	370·75	342·81	309·1	285·06
	Gorilla (3)	♀ 309·0		304·9		253·0	
	Pithecanthropus erectus ...	455·0		437·0		394·0	
Primogenial Man	Neanderthal Type	423·0		406·5		354·0	
	Galley Hill	424·0		?		< 370·0	
	Cromagnon	528·0		511·0		[462]	
	Grimaldi Type	[480·0]		[467·0]		—	
	H. aurignacensis (*Hauseri*)	425·0		410·0		c. 374	
Recent Man	Australians	♂ 471·6	Mean ♂ 440·9, ♀ 407·5	—	Mean ♂ 412·7, ♀ 384·9	—	[Mean ♂ 378·1, ♀ 347·0]
		♀ 426·3		—		—	
	Berbers and Guanches	♂ 449·9		422·8		—	
		♀ 424·2		398·7		—	
	Negroes	♂ 451·7		—		—	
		♀ 415·7		—		—	
	17th century Londoners	♂ 447·24		425·81		378·14	
		♀ 409·19		389·16		347·02	
	Neolithic Europeans	♂ 444·0		—		—	
		♀ 410·0		—		—	
	Maori and Moriori ...	♂ 440·7		421·8		—	
		♀ 407·3		402·0		—	
	Fuegians	♂ 433·7		420·4		—	
		♀ 403·5		390·2		—	
	N. American Indians	♂ 421·6		397·2		—	
		♀ 389·9		368·1		—	
	Japanese, Aino ...	♂ 408·0		388·0		—	
	Indo-Chinese ...	♀ 381·0		361·0		—	

Now this subdivision of the Lemuroids leads us to a most interesting fact: With one possible exception, the *Hapalinae*[1], where the maximum and trochanteric lengths are sensibly equal, all the genera measured of the *Cebidae* have a maximum length greater than their trochanteric length, and this is of course true of the *Cebidae* as a whole. On the other hand, for every single genera of the *Simiadae*, and therefore for the whole family, the trochanteric length is greater than the maximum length. This relative size of the maximum and trochanteric femoral lengths thus serves to differentiate *Cebidae* from *Simiadae*, and also differentiates the *Lemurinae* and *Indrisinae* from the rest of the Lemuroids. Accordingly the suggestion may be made that the *Cebidae* are derived from a form approximating to the Tarsiidean, and the *Simiadae* from a form approximating to the Lemurine group of the Lemuroids. From this standpoint it would be of undoubted interest to have a full study of the femora of the Lemuroids from the North American Eocene deposits and their comparison with the European fossil *Adapinae.*

We note the usual increases in size from Lemuroids to *Simiadae* and so to *Simiinae*; then in the *Hominidae* size increases from Neanderthal to Cromagnon Type and falls again to Recent Man. The fossil Gibbon, as represented by *Dryopithecus rhenanus*, stands in absolute size between Orang and Chimpanzee, and the modern Gibbon represents a diminution in size by 48 °/ₒ. It may be argued that all the *Simiinae* are degenerates in size, but the more rational view is that the Greater Anthropoids have developed to a maximum utile size with a view to strength, while the Gibbon has diminished to the minimum utile size with regard to agility[2]. Now if we turn to *Pithecanthropus erectus* we note that Schwalbe in his descent, *Pithecanthropus*—Neanderthal Man—Recent Man, has overlooked, for what it is worth, this question of absolute size. *Pithecanthropus erectus* had a stature of 166·8 cms., or a femur length about equal to that of the average male Rothwell English, or those of the male Guanches or British neolithic men. If we suppose the trinil femur not to be that of Recent Man, we must hold that *Pithecanthropus*' immediate predecessors had a femur of the size-order of the fossil Gibbon or something about that of the recent Greater Anthropoids. Thus we have the see-saw: the rise from Anthropoid to *Pithecanthropus*, then, the fall to the Neanderthal Type, the rise to the Cromagnon Type and the fall again to Recent Man. These size change fluctuations—less serious indeed than ratio change fluctuations—still confirm what we have advanced elsewhere in this monograph, *i.e.* that the predecessor of Neanderthal and of Recent Man must be credited with a troglodyte rather than a hylobatic—to say nothing of a completely "Recent Man"—femur.

(*b*) *Epiphysial Development and Diaphysio-epiphysial Index.*

While all three lengths place the genera of primates in the same size-order, yet if we take the absolute difference, Maximum Length less Diaphysial Length, the size-order only remains the same for the *Simiadae*. In other words, the development of the epiphyses has not proceeded in all genera *pari passu* with the development of the diaphysis. If we divide the above absolute difference by the diaphysial length itself we obtain an index which will be a *rough* measure of the development in each genus of the epiphyses relative to that of the diaphysis. We may term this index, the ratio being of course multiplied by the usual 100, the Diaphysio-epiphysial Index.

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[1] In this point the marmosets are closer to the Old World monkeys than the bulk of New World monkeys are. The marmosets are usually described as the lowest group of American monkeys. They are very frequently raised into a separate family, the *Hapalidae*.

[2] Possibly in the same manner that *Ateles* among the New World monkeys has developed to much the same size, in this case again a maximum utile size with regard to agility.

The results are indicated in the next table.

TABLE XVII. *Epiphysial Development and Diaphysio-epiphysial Index.*

	Genus	Maximum Length—Diaphysial Length			Genus	Diaphysio-epiphysial Index	
Lemuroidea	*Tarsiidae* (2)	8·7	Mean 9·82	Mean 13·15	*Indrisinae* (8)	11·6	Mean 15·59
	Galaginae (6)	9·7			*Chiromyrdae* (2)	13·7	
	Lorisinae (6)	11·05			*Tarsiidae* (2)	15·7	
	Chiromyrdae (2) ...	15·0	Mean 16·48		*Lorisinae* (6)	16·8	
	Indrisinae (8)	15·75			*Lemurinae* (18)	16·95	
	Lemurinae (18) ...	18·7			*Galaginae* (6)	18·8	
Cebidae	*Hapalinae* (16)	8·9	Mean 17·74		*Pithecia* (2)	12·6	Mean 15·49
	Nyctipithecinae (8) ...	11·0			*Brachyurus* (2)	13·2	
	Pithecia (2)	14·55			*Nyctipithecinae* (8) ...	14·1	
	Cebus (6)	15·8			*Cebus* (6)	15·2	
	Lagothrix (2)	17·3			*Hapalinae* (16)	15·6	
	Brachyurus (2)	18·05			*Mycetes* (2)	16·1	
	Mycetes (2)	21·0			*Lagothrix* (2)	18·3	
	Ateles (4)	35·3			*Ateles* (4)	18·8	
Simiadae	*Cercopithecus* (8) ...	18·7	Mean 25·39		*Cercocebus* (4)	14·8	Mean 15·22
	Macacus (14)	24·0			*Cynocephalus* (8) ...	15·0	
	Semnopithecus (10) ...	26·1			*Semnopithecus* (10) ...	15·0	
	Cercocebus (4)	28·35			*Cercopithecus* (8) ...	15·2	
	Cynocephalus (8) ...	29·8			*Macacus* (14)	16·1	
	Dryopithecus rhenanus (1)	31·1			*Dryopithecus rhenanus* (1)	12·2	
Siminae	Gibbon (2)	28·85			Gibbon (2)	16·9	
	Chimpanzee (2)	52·75	Mean 54·96		Chimpanzee (2)	20·1	Mean 23·50
	Orang (5)	54·5			Gorilla (7)	20·5	
	Gorilla (7)	57·62			Orang (5)	29·9	
	Pithecanthropus erectus (1)	61·0			*Pithecanthropus erectus* (1)	15·5	
Hominidae	Neanderthal Type ...	69·0			Neanderthal Type ...	19·5	
	Recent Man (17th century Londoners)	♂ 69·10 ♀ 62·17	65·63		Recent Man (17th century Londoners)	♂ 18·3 ♀ 17·9	18·1

While certain changes in the serial order of size arise if we consider only the epiphysial portion of the maximum length, they are not of much importance except in the case of the Greater Anthropoids. There are no changes in the *Simiadae*; in the *Cebidae* only such changes as might well arise from the smallness of our samples of certain of the genera. In the *Lemuroidea* our Tarsiidean and Lemurine groups still remain apart, if the order within the groups has been modified by the *Tarsiidae* changing places with the *Galaginae* and the *Indrisinae* with the *Lemurinae.* The most interesting point, however, is that the Orang now replaces the Chimpanzee, standing next to the Gorilla for epiphysial development, in this case chiefly that of the distal epiphysis, which shows for the *Simiinae* a relatively high patellar surface.

If we turn to the Diaphysio-epiphysial Index we note at once that its mean value is practically the same for Lemuroids, *Cebidae* and *Simiadae*; if anything the monkeys have a slightly lower value than the Lemuroids. But the range of the Lemuroid genera covers the whole range of the genera of *Cebidae* and a good deal more than covers the range of genera of the *Simiadae.* In fact, the range of variation is considerably less in the lesser ape genera than in the Lemuroid genera.

The serial order within the families is quite changed, however, from that of absolute size, thus indicating that in the genera the relative development of diaphysis and epiphyses has been entirely different. Thus in the *Lemuroidea*, the genus of largest size, the *Indrisinae*, has had least development of the epiphyses relative to the diaphysis, and the *Galaginae*, the least in size, the greatest. On the other hand, in the *Cebidae*, *Ateles*, the greatest in size, has had the greatest development of the epiphyses relative to the diaphysis, while the *Hapalinae*, the least in size, has the mean development of epiphyses relative to diaphysis. With the *Simiadae*, however, we return to the Lemuroid relations, for *Cercopithecus* and *Cynocephalus*, the least in absolute size, show the greatest development of epiphyses relative to diaphysis, and *Cercocebus* and *Macacus*, the greatest in size, show the least development. This rule also practically applies to the Greater Anthropoids, where the Orang, least in absolute size, has an exceptionally high development of epiphyses relative to the diaphysis, and the Gorilla, greatest in absolute size, has a Diaphysio-epiphysial Index only just about equal to that of the far smaller Chimpanzee. Even in the *Hominidae*, Neanderthal, with the least size, has the greatest development of the epiphyses relative to the diaphysis, and with Recent Man, with the greater size, that development is less.

Thus—notwithstanding the apparent exception of the *Cebidae*[1]—it appears to be the rule that in general short femoral shafts are associated with relatively large epiphyses and large femoral shafts with relatively small epiphyses.

We have seen that the mean Diaphysio-epiphysial Index remains very nearly the same for *Lemuroidea*, *Cebidae* and *Simiadae.* But with the Greater Anthropoids comes a 54 °/ₒ increase. This increase was not maintained in Neanderthal Man, although he is but little below the Chimpanzee, and falls still further in the case of Recent Man. It still remains, however, much above the *Simiadae* level. *Pithecanthropus erectus* is within the human range and is nearer to the human mean than to the fossil Gibbon; it is, however, closer to the Recent Gibbon than to Recent Man, although we should have anticipated that if it were a forerunner of Man it would be nearer to the fossil than to the Recent Gibbon. Clearly the present adds another to the cases in which Man is interposed between the *Simiadae* and the Greater Anthropoids. This does not, however, signify that Man is even for this character nearer to the fossil Gibbon than to the Recent Chimpanzee.

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[1] The exception is not so great as it appears at first sight, *Brachyurus* and *Pithecia* in the second half of the table for size are in the first half for Diaphysio-epiphysial Index; *Lagothrix* and *Hapalinae* in the first half for size pass to the second half for index; *Nyctipithecinae* advance one place in the right direction, while *Cebus*, *Mycetes* and *Ateles* are the exceptions to the rule in that they do not change their serial position, but they do not move in the wrong direction.

III. Bowing of the Primate Femur.

We are able to extend considerably our ideas of bowing in the primate femur from fuller data for the lesser apes. In the first place the mean bowing of the Lemuroids is *negative*, and this fact should be taken in association with the appearance of what we have termed the "frontal pilaster": see Plate LXV and the Table of Measurements of the Primate Femur in Atlas, Part II.

Table XVIII. *Indices of Bowing in Primates.*

	Group	Primary Index			Group	Secondary Index		
Lemuroidea	*Lorisinae* (6)	– 2·4		Mean – ·54	*Tarsiidae*	29·7		Mean 43·05
	Galaginae (6)	– 1·35			*Lorisinae*	30·9		
	Tarsiidae (2)	– 1·25			*Chiromyrdae*	39·9		
	Lemurinae (18)	0·0			*Galaginae*	44·4		
	Indrisinae (8)	0·6			*Lemurinae*	47·8		
	Chiromyrdae (2)	1·15			*Indrisinae*	65·6		
Cebidae	*Nyctipithecinae* (8) ...	0·9		Mean 1·87	*Pithecia*	40·55		Mean 46·90
	Pithecia (2)	1·25			*Mycetes*	41·3		
	Cebus (6)	1·45			*Nyctipithecinae*	46·35		
	Lagothrix (2)	1·7			*Brachyurus*	47·75		
	Brachyurus (2)	1·95			*Lagothrix*	48·65		
	Ateles (4)	2·3			*Cebus*	49·0		
	Hapalinae (16)	2·4			*Ateles*	50·3		
	Mycetes (2)	3·0			*Hapalinae*	51·3		
Simiadae	*Semnopithecus* (10) ...	2·8		Mean 3·50	*Semnopithecus*	43·0		Mean 47·49
	Cercocebus (4)	3·1			*Cercopithecus*	46·2		
	Cynocephalus (8)	3·7			*Cynocephalus*	47·7		
	Macacus (14)	3·8			*Macacus*	49·1		
	Cercopithecus (8)	4·1			*Cercocebus*	51·45		
	Dryopithecus rhenanus (1)	0·6			*Dryopithecus rhenanus* ...	39·4		
Simiinae	Gibbon (2)	– 0·15			Gibbon	70·95?		
	Orang (5)	1·8		Mean 2·71	Chimpanzee	42·95		Mean 45·38
	Chimpanzee (2)	2·95			Orang	45·2		
	Gorilla ♂ (4)	3·5	3·37		Gorilla ♂	47·6	47·99	
	,, ♀ (3)	3·2			,, ♀	48·5		
	Pithecanthropus erectus (1)	2·8			*Pithecanthropus erectus* ...	48·7		
Hominidae	Neanderthal Type ...	3·7		Mean 3·31	Neanderthal Type ...	53·5		Mean 50·67
	Galley Hill	2·7			Galley Hill	67·1		
	Cromagnon Type	4·3			Cromagnon Type ...	43·1		
	Grimaldi Type	—			Grimaldi Type	—		
	H. aurignacensis (Hauseri)	—			*H. aurignacensis (Hauseri)*	—		
	Recent Man (17th century Londoners) ♂	2·55	2·53		Recent Man (17th century Londoners) ♂	36·85	38·99	
	♀	2·50			♀	41·13		

But an analysis of the individual genera shows that in what we have termed the Tarsiidean group (*Lorisinae, Galaginae,* and *Tarsiidae,* with possibly the Aye-Aye as a transitional form) the bowing is negative, mean value: – 1·7, while in the Lemurs it is zero, and small and positive in the *Indrisinae*[1]. It will be noticed that the mean secondary index is 35·0 for the Tarsiidean group and 51·1 for the Lemurine group, if we include *Chiromys,* but 56·7 if we exclude it. Thus the point of maximum curvature is more proximal in the case of the less bowing, more distal in the case of the greater bowing. This phenomenon evidenced in the Lemuroids can be traced, not without marked exceptions, higher up in the scale. Thus *Lagothrix, Brachyurus, Ateles* and the marmosets of the *Cebidae* are among the most bowed and have their points of maximum curvature lowest, *i.e.* their mean primary and secondary indices are 2·1 and 49·5 as against 1·65 and 44·3 for the remainder. *Mycetes* is a bad exception, but again the smallness of the sample must be regarded. *Semnopithecus* illustrates the principle in the *Simiadae,* and to a lesser extent *Macacus,* but *Cercocebus* and *Cercopithecus* are anomic. The Gibbon is very anomalous, but in the case of so small a bowing it is practically impossible to determine with any accuracy the point of maximum curvature. It is true for Recent Man relative to Neanderthal Man, but the Cromagnon Type seems to be an exception. Generally we have:

	Primary Index	Secondary Index
Lemuroidea	– 0·54	43·05
Cebidae	1·87	46·90
Simiinae (less Gibbon)	2·71	45·38
Hominidae	3·31	50·67
Simiadae	3·50	47·49

which shows the extent of truth in the rule. At the same time the reader must bear in mind the danger that spurious correlation may be the source of the observed sequences.

What, however, seems clear is that from Lemuroids to Lesser Apes the bowing increases from practical insignificance to very sensible values and that the point of maximum curvature approaches nearer to the middle of the shaft. The gibbons are the only anthropoids which have acquired, or retained, a low bowing. In this respect *Pithecanthropus* is very ungibbonlike, and approaches the Greater Anthropoids, being well, however, within the human range. The Greater Anthropoids are, however, less bowed than the *Simiadae,* and in this respect the Neanderthal Type seems closer to the *Simiadae* than to the *Simiinae,* a relationship found in quite a number of characters. This excess of bowing reaches its maximum in Cromagnon, and then declines in value to Recent Man, who is nearer to the Greater Anthropoids than to Primogenial Man or to the *Simiadae.* Those who place faith in a hylobatic ancestor of man will have grave difficulty in explaining how the marked bowing of the branch-point of the *Simiadae* on the primate stem was lost in that hylobatic ancestor and regained once more with the *Hominidae.* Orderly evolution seems to demand a protsimio-human with the bowing of a troglodyte, and the point of maximum curvature rising somewhat proximally as that bowing is to some extent weakened in Recent Man. As far as we can trust results based on indices both very difficult of accurate determination and showing in the individual species of the genera great variation, bowing further appears to support the view that *Cebidae* are closer to the Tarsiidean, and *Simiadae* to the Lemurine section of the Lemuroids, *i.e.* to the possibility that the New World monkeys were differentiated from their Lemuroid ancestry, before the Lemurine group was fully developed.

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[1] Our sample is too small to be certain of the value we give for *Chiromys.*

IV. OBLIQUITY OF THE PRIMATE FEMUR.

The following table gives our results for the various genera of apes and for the types of *Hominidae*. There is a general increase of obliquity from the Lemuroids upwards, culminating in Cromagnon Man and then falling slightly to Recent Man. But certain strange exceptions occur. We note first that the *Cebidae* have rather a low mean obliquity, even below that of the *Lemuroidea*. This is to some extent accounted for by the negative obliquity of the very anomalous *Lagothrix*. If we take *Mycetes, Ateles, Pithecia* and *Cebus*, with a mean obliquity of 3°·2; this is roughly associable with the mean 3°·8 of the Tarsiidean section of the Lemuroids. But the lower values of *Nyctipithecinae* and especially *Hapalinae* are *pro tanto* against the view of a Tarsiidean in contradistinction to Lemurine origin for the *Cebidae*. At any rate that family has made nothing like the progress in femoral obliquity of the *Simiadae*, where again we have another instance of the Old World monkeys outstripping the Anthropoids and being nearer to Recent Man than the latter. Indeed the *Simiinae* present certain noteworthy features. The order of our present table is

TABLE XIX. *Obliquity of Femur in Primates.*

	Group	Obliquity	
Lemuroidea	*Chiromyrdae* (2) ...	0°·0	Mean 2°·45
	Indrisinae (8) ...	1°·2	
	Lemurinae (18) ...	2°·2	
	Galaginae (6) ...	2°·1	
	Tarsiidae (2) ...	3°·7	
	Lorisinae (6) ...	5°·5	
Cebidae	*Lagothrix* (2) ...	−2°·2	Mean 1°·66
	Nyctipithecinae (8)	−0°·1	
	Hapalinae (16) ...	1°·4	
	Brachyurus (2) ...	1°·5	
	Mycetes (2)... ...	2°·0	
	Ateles (4)	3°·35	
	Pithecia (2) ...	3°·4	
	Cebus (6)	3°·9	
Simiadae	*Cercocebus* (4) ...	6°·25	Mean 6°·75
	Semnopithecus (10)	6°·4	
	Cercopithecus (8) ...	6°·6	
	Macacus (14) ...	7°·2	
	Cynocephalus (8) ...	7°·3	

	Group	Obliquity		
	Dryopithecus rhenanus (1) ...	4°·0		
Simiinae	Gibbon (2)	3°·0		Mean 2°·48
	Orang (5)	5°·2		
	Gorilla ♂ (4)	2°·9	1°·83	
	,, ♀ (3)	0°·4		
	Chimpanzee	−0°·1		
	Pithecanthropus erectus (1) ...	12°·0		
Primogenial Man	Neanderthal Type (7) ...	4°·1		Mean 8°·6
	Galley Hill (1)	8°·5		
	Cromagnon Type (5) ...	12°·5		
	Grimaldi Type (2)	10°·0		
	Homo aurignacensis (*Haus.*) (1)	7°·9		
Recent Man	17th century Londoners ♂ ...	10°·19	10°·4	
	,, ,, ♀ ...	10°·61		

practically the same as that on p. 240, although the individuals are far from identical. The negative character of the obliquity in the Chimpanzee and the very small obliquity in the female Gorilla—does this indicate a closer relation in that sex to a Chimpanzee ancestry?—deserve note and if possible confirmation. The relatively low values for the Chimpanzee and Gorilla may be the result of a recent regression, but *Dryopithecus rhenanus* does not suggest much scope in this direction, and it may be better to attribute the higher position of the *Simiadae* to a recent advance[1]. Again, the low value of Man of the Neanderthal Type does not suggest a value higher than 3° to 4° for the protsimio-human, and this would be well out of touch with *Pithecanthropus erectus,* which is quite in the human range, is remote from fossil and recent Gibbons, and has almost the maximum value reached by Cromagnon Man himself. Galley Hill is intermediate between Neanderthal and Cromagnon Man, and the Grimaldi Type indicates the descent from Cromagnon to Recent Man. The rapid rise to Cromagnon and the later descent is parallel to what happens in many characters, and badly needs explanation, but the balance of gain from Neanderthal to Recent Man may very probably be associated with improved uprightness. Is greater uprightness of gait a differential mark between recent and fossil *Simiadae,* or between the Old and New World monkeys?

V. The Midtrochlear Angle of the Primate Femur.

This is the second independent angle of the fundamental triangle of the femur, the Collar Angle being the first. It is the angle which the bust or capito-collar axis subtends at the midtrochlear point, and is the least variable of the three angles of the fundamental triangle. The Lemuroids show the usual difference between the Tarsiidean and Lemurine groups with the customary intermediate position of the *Chiromyrdae,* the Lemurine group pointing as usual in the direction of ascent. The ascent in value is quite appreciable in the *Cebidae,* but more noticeable in the *Simiadae*; for although the midtrochlear angles of *Mycetes* and *Lagothrix* exceed those of *Macacus* and *Cynocephalus,* the *Cebidae* have a number of low values which can only be paralleled by those of the Tarsiidean group of the Lemuroids, and confirm the view previously expressed that the *Cebidae* have closer association with the Tarsiidean group than the *Simiadae*[2].

While the *Cebidae* and *Simiadae* have increased their midtrochlear angles $20\,^\circ\!/_\circ$ roughly on the Lemuroids, the Gibbons are only slightly above the mean of the *Simiadae* and show their usual close relationship to *Ateles* (*Dryopithecus rhenanus* 7°·0, *Ateles* 7°·1, Recent Gibbon 7°·25). On the other hand, the Greater Anthropoids have increased $50\,^\circ\!/_\circ$ on the *Simiadae.* The increase in the Gorilla is very noticeable, and this character, as so many others, places him quite out of court as a claimant to any close human ancestry. The Chimpanzee, on the other hand, runs fairly parallel to the Neanderthal Type; Galley Hill is a transition to Recent Man, while the anomalous position of Cromagnon is further evidence of that overshooting of the mark that we have frequently had to note in this "exaggerated recent man" type. The whole of the data suggests a protsimio-human with a midtrochlear angle of about 7°·5. *Pithecanthropus erectus* falls well into the human range, but on the other side of it to what we may suppose the protsimio-human to lie. But the test is of little value, except as confirming others, for a midtrochlear angle of 8°·0 might well alone and in a single individual indicate a member of the Gibbon, the Chimpanzee or the Human group. The main features of the table are precisely those we have so often met with: the continuous rise in one sense of the character from the *Lemuroidea* to the Greater Anthropoids, the interpolation of the *Hominidae* between *Simiadae* and the Greater Anthropoids, accompanied by a quite sensible fall from Primogenial Man of the Neanderthal Type to Recent Man, which carries the latter somewhat closer still to the Old World monkeys, and the suggestion that the protsimio-human would be more Chimpanzee-like than Gibbon-like, more "Manlike" indeed if we think under that term of a dwarfed and weakened form of Neanderthal Man.

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[1] From this standpoint the bowing of the fossil *Simopithecus oswaldi* is of much interest, it is 4·1, close to *Dryopithecus rhenanus* and suggesting but, of course, as a single individual not demonstrating a recent rise in the *Simiadae.*

[2] The range of generic values for this character in the *Cebidae* appears to be quite double that in the *Simiadae,* a fact which suggests a wider range of origin in the former group.

TABLE XX. *Midtrochlear Angle in the Primates.*

	Group	Midtrochlear Angle	
Lemuroidea	*Tarsiidae* (2) ...	4°·3	Mean 5°·50
	Galaginae (2) ...	5°·3	
	Lorisinae (6) ...	5°·5	
	Chiromyrdae (2) ...	5°·5	
	Indrisinae (8) ...	5°·7	
	Lemurinae (18) ...	6°·7	
Cebidae	*Brachyurus* (2) ...	5°·0	Mean 6°·51
	Nyctipithecinae (8)	5°·45	
	Pithecia (2) ...	5°·7	
	Hapalinae (16) ...	5°·9	
	Cebus (6)	6°·4	
	Ateles (4)	7°·1	
	Mycetes (2) ...	8°·0	
	Lagothrix (2) ...	8°·5	
Simiadae	*Cercocebus* (4) ...	6°·25	Mean 6°·75
	Semnopithecus (10)	6°·4	
	Cercopithecus (8) ...	6°·6	
	Macacus (14) ...	7°·2	
	Cynocephalus (8) ...	7°·3	

	Group	Midtrochlear Angle		
	Dryopithecus rhenanus (1) ...		7°·0	
Simiinae	Gibbon (2)		7°·25	
	Gorilla ♂ (4)...	13°·9	12°·74	Mean 9°·91
	,, ♀ (3)...	11°·2		
	Chimpanzee (2)		9°·0	
	Orang-utan (5)		8°·0	
	Pithecanthropus erectus (1) ...		8°·0	
Primogenial Man	Neanderthal Type (7) ...		9°·6	Mean 8°·26
	Galley Hill (1)		8°·0	
	Cromagnon Type (5) ...		6°·7	
	Grimaldi Type (2)		8°·5	
	Homo aurignacensis (*Hauseri*)		[8°·5]	
Recent Man	17th century Londoners ♂ ...	7°·85	7°·79	
	,, ,, ♀ ...	7°·73		

VI. THE TORSION OF THE PRIMATE FEMUR.

We have on pp. 23—30, 239—242 indicated to the reader the difficulties which attend the interpretation of femoral torsion owing to the want of standardisation in the methods of measurement. In the present table the whole of the data are obtained by a single method except the values for Cromagnon and *Pithecanthropus erectus,* which we have taken from Rodriguez and Dubois respectively. The sole difference

TABLE XXI. *Torsional Angles of Femur in Primates**.

	Group	Torsion of Femur		Group	Torsion of Shaft		Group	Retorsion	
Lemuroidea	*Lorisinae* (6)	−18°·7	−10°·63 Mean −2°·65	*Lorisinae*	−20°·4	−7°·97 Mean +1°·65	*Lorisinae*	−1°·7*	* +2°·67 † +5°·95 Mean +4°·31
	Tarsiidae (2)	−10°·2		*Tarsiidae*	−3°·0		*Galaginae*...	+2°·5*	
	Galaginae (3)	−3°·0		*Galaginae*...	−0°·5		*Indrisinae*	3°·1†	
	Chiromyrdae (2)	−3°·0	+5°·33	*Chiromyrdae*	7°·5	+11°·27	*Lemurinae*	4°·25†	
	Lemurinae (18)	7°·4		*Lemurinae*	11°·7		*Tarsiidae*	7°·2*	
	Indrisinae (8)	11°·6		*Indrisinae*	14°·6		*Chiromyrdae*	10°·5†	
Cebidae	*Mycetes* (2)...	−12°·7	−7°·95 Mean +1°·54	*Mycetes*	−21°·0	−10°·95 Mean +3°·46	*Ateles*	−8°·9*	* −3°·00 † +6°·81 Mean +1°·90
	Lagothrix (2)	−9°·7		*Ateles*	−13°·0		*Mycetes*	−8°·3*	
	Cebus (6)	−5°·3		*Lagothrix*...	−8°·3		*Lagothrix*...	1°·4*	
	Ateles (4)	−4°·1		*Cebus*	−1°·5		*Brachyurus*	2°·75†	
	Hapalinae (16)	8°·2	+11°·04	*Hapalinae*	16°·1	+17°·88	*Cebus*	3°·8*	
	Nyctipithecinae (8) ...	10°·2		*Nyctipithecinae*	17°·5		*Nyctipithecinae*	6°·2†	
	Pithecia (2)	11°·0		*Brachyurus*	16°·4		*Hapalinae*	7°·8†	
	Brachyurus (2)	14°·75		*Pithecia*	21°·5		*Pithecia*	10°·5†	
Simiadae	*Cercocebus* (4)	8°·75	Mean 12°·63	*Cercopithecus*	1°·5	Mean 4°·21	*Cercopithecus*	−13°·55	Mean −8°·48
	Macacus (14)	9°·4		*Semnopithecus*	1°·85		*Semnopithecus*	−9°·6	
	Semnopithecus (10) ...	11°·45		*Cercocebus*	4°·0		*Cynocephalus*	−9°·5	
	Cercopithecus (8)	15°·05		*Macacus*	4°·45		*Macacus*	−5°·0	
	Cynocephalus (8)	18°·5		*Cynocephalus*	9°·1		*Cercocebus*	−4°·75	
	Dryopithecus rhenanus (1)	13°·5		*Dryopithecus rhenanus* ...	7°·0		*Dryopithecus rhenanus* ...	−6°·5	
Simiinae	Gibbon (2)	16°·0		Gibbon	5°·25		Gibbon	−10°·75	
	Orang-utan (5)	−5°·65	Mean 1°·90	Orang-utan	5°·8	Mean 7°·68	Gorilla ♂	1°·5	−0°·86 Mean +5°·78
	Chimpanzee (2)	3°·75		Gorilla ♂	11°·25	6°·73	,, ♀	−4°·0	
	Gorilla ♂ (4)	9°·75	7°·59	,, ♀	0°·7		Chimpanzee	6°·75	
	,, ♀ (3)	4°·7		Chimpanzee	10°·5		Orang-utan	11°·45	
	Pithecanthropus erectus ...	15°·0		*Pithecanthropus erectus* ...	—		*Pithecanthropus erectus* ...	—	
Primogenial Man	Neanderthal Type... ...	10°·2	20°·07	Neanderthal Type ...	23°·4	24°·2	Neanderthal Type ...	13°·2	11°·6
	Galley Hill (1)	15°·0		Galley Hill	25°·0		Galley Hill	10°·0	
	Cromagnon Type	35°·0		Cromagnon Type... ...	—		Cromagnon Type... ...	—	
	Grimaldi Type	—		Grimaldi Type	—		Grimaldi Type	—	
	H. aurignacensis (*Hauseri*)	—		*H. aurignacensis* (*Hauseri*)	—		*H. aurignacensis* (*Hauseri*)	—	
Recent Man	17th century Londoners ♂	13°·21	14°·67	17th century Londoners ♂	24°·26	24°·90	17th century Londoners ♂	11°·24	10°·26
	,, ,, ,, ♀	16°·13		,, ,, ,, ♀	25°·55		,, ,, ,, ♀	9°·28	

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* Names without numerical values in this table as in several others are inserted in the hope that the custodians of the bones in question may be induced to supply the missing values.

lies in the application of the method, the measurement of the Apes and Lemuroids being due to Pearson and that of the 17th century Londoners to one of the Laboratory staff working under his superintendence. Unfortunately we have no values for the torsional angles in either *Homo aurignacensis* (*Hauseri*), or in the Grimaldi femora, and none for the torsion of the shaft in Cromagnon.

The results are such as we have already become familiar with in other characters, *i.e.* a rise from Lemuroids to Lesser Apes, a fall in the Greater Anthropoids, but a continuous rise in Primogenial Man as a whole followed by a fall to Recent Man. The details, however, will well repay study.

In the first place we see the Tarsiidean group differentiated from the Lemurine group by the possession of a *negative* torsion, very high indeed in the *Lorisinae*, the Aye-Aye as usual taking an intermediate place. This differentiation into positive and negative groups is maintained in the torsion of the shaft as well as the torsion of the femur as a whole, and is summarised in the following figures:

	Torsion of Femur		Torsion of Shaft		Retorsion	
Tarsiidean Group ...	– 10°·63	– 2°·65	– 7°·97	+ 1°·65	+ 2°·67	+ 4°·31
Lemurine Group ...	+ 5°·33		+ 11°·27		+ 5°·95	

While none of the *Simiadae* shows any trace of negative torsion in the whole femur or in the shaft only, it is exhibited in one-half the genera of the *Cebidae* with which we have dealt, namely, in *Mycetes*, *Lagothrix*, *Cebus* and *Ateles*. On the other hand, the *Hapalinae*, *Nyctipithecinae*, *Pithecia* and *Brachyurus* have positive torsion. If we speak of these for the convenience of the moment as the Mycetean and Nyctipithecine groups we may summarise as follows:

	Torsion of Femur		Torsion of Shaft		Retorsion	
Mycetean Group ...	– 7°·95	+ 1°·54	– 10°·95	+ 3°·46	– 3°·00	+ 1°·90
Nyctipithecine Group ...	+ 11°·04		+ 17°·88		+ 6°·81	

and write for the *Simiadae*:

Simiadae	12°·63	4°·21	– 8°·48

Now even if some of the small negative and positive torsions be fortuitous and due to individual variation, and not to any evolutionary link, still the above manner of looking at the results indicates that there are generic negative torsions in the *Cebidae* and none at all in the *Simiadae*, and thereby suggests that the former group is more closely related than the latter to the Tarsiidean element in the Lemuroids. The inclusion of *Ateles* in the negative torsion group of the *Cebidae* and the exclusion of the primitive marmosets must of course be noted. It is singular that *Ateles*, which in so many characters resembled *Hylobates*, differs in torsional characters so widely from both *Dryopithecus rhenanus* and the Recent Gibbons. Both these have considerable positive torsions and noteworthy negative retorsion, in these matters running very parallel to the *Simiadae*, which have all considerable positive torsions and marked negative retorsion.

The upward rise from negative or small torsions in the Lemuroids to large torsions in the *Simiadae* and the fall from small positive to large negative retorsions, is not maintained in the Greater Anthropoids. It is true that the torsion of the shaft still continues to increase right up to Recent Man, *i.e.* we have:

	Torsion of Shaft		Torsion of Shaft
Lemuroidea	+ 1°·65	*Simiinae*	+ 7°·07
Cebidae	+ 3°·46	Neanderthal Man	+ 23°·4
Simiadae	+ 4°·21	Recent Man	+ 24°·9

And this series confirms our belief that the torsion of the shaft is of great evolutionary importance.

But of the Greater Anthropoids the average femoral torsion is only +1°·90, and the Orang returns to a Tarsiidean condition of negative femoral torsion. The result is manifest in the retorsion, which is only negative in the female Gorilla and has a mean value in excess of any yet met with for the other families of apes.

The position of the *Hominidae* then admits of more than one manner of description because we do not know which of our three torsional characters are to be considered primary. If, as we have suggested (p. 286), the torsion of the shaft is primary as tending to strengthen the femur as a strut by bringing its transverse axis somewhat toward the plane of maximum flexural load and the retorsion primary as tending to rectify the influence of this torsion of the shaft on the general position of the thigh bone, then Man has followed the same line of evolution as the Greater Anthropoids, *i.e.* he has continued in a most marked manner the increasing torsion of the shaft, and the positive retorsion. In this case the increasing torsion in the femur as a whole is only incidental to the above primary factors. On the other hand, if we take the torsion of the femur as a primary factor, we must admit that the evolutionary history of the Greater Anthropoids has diverged considerably from that of Man, who has followed more closely the upward rise in the torsion of the femur taken by the *Simiadae*, while the Greater Anthropoids have reverted to a more Lemuroid condition. Both Anthropoids and Man would then have maintained the upward tendency in the torsion of the shaft, while the marked differences of retorsion in the *Simiadae*, Greater Anthropoids and Man would be merely incidental and of no evolutionary importance. Still a third view may be taken, namely, that the torsional angle of the femur and the retorsion are the primary factors—and this view receives some support from the fact that their absolute variations are less than those of the torsion of the shaft: see Table, p. 162—and that the torsion of the shaft is of no evolutionary importance. In this case the *Simiadae* increased one important factor and the Greater Anthropoids the other, while Man came between the two and increased both.

Whichever interpretation be given—and we shall probably not be able to settle between them, until we know more of the relation of torsion to (i) strut strength in the shaft and (ii) uprightness of gait—the low torsional angle of the Greater Anthropoids is noteworthy[1]. We can hardly believe—in view of the *Simiadae* value—that the protsimio-human had a less value of the torsional angle than the 10° of

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[1] The values in the present table are fairly in accord with the much longer series chiefly due to other femoralogists in the Table on p. 243 of this Chapter. The Orang has still negative torsion; the Gorilla has a value which might well arise from a somewhat larger proportion of females; the Chimpanzee value accords within the limits of our small sample. The only serious difference is that of the much longer Gibbon series. Our value is halved and thus brought much further out of accord with *Dryopithecus rhenanus*.

Neanderthal Man, and if so the Greater Anthropoids in their recent forms must have regressed on this, while Primogenial Man advanced enormously to the Cromagnon value, whence as usual the character recedes to the Recent Man value. Taken as a whole many unsolved problems are suggested by this discussion of torsion in the primate femur. We want much better data for Primogenial Man.

VII. On the Diameters and Indices of the Fundamental Sections of the Primate Shaft.

(*a*) *Diameters and Index of the Platymeric Section.*

Let us look first at the platymeric index. We note at once that the mean platymeric index for the Lemuroids does not show a high degree of platymery, and that the

Table XXII. *Diameters and Index of Platymeric Section.*

	Group	Platymeric A.P. Diameter		Platymeric Transverse Diameter		Platymeric Index		
Lemuroidea	*Tarsiidae* (2)	3·1	Mean 5·70	3·5	Mean 6·39	*Chiromyrdae*	82·95	Mean 91·65
	Galaginae (6)...	4·0		3·9		*Indrisinae*	87·8	
	Lorisinae (6)	4·5		4·9		*Tarsiidae*	88·85	
	Chiromyrdae (2)	7·05		8·5		*Lorisinae*	91·2	
	Indrisinae (8)	7·45		8·65		*Lemurinae*	91·6	
	Lemurinae (18)	8·1		8·9		*Galaginae*	107·5	
Cebidae	*Hapalinae* (16)	4·0	Mean 7·81	4·4	Mean 8·69	*Nyctipithecinae*	85·5	Mean 90·20
	Nyctipithecinae (8)	4·6		5·55		*Cebus*	86·8	
	Pithecia (2)	6·7		7·6		*Pithecia*	88·2	
	Cebus (6)	6·9		8·2		*Brachyurus*	88·5	
	Brachyurus (2)	7·7		8·7		*Hapalinae*	91·2	
	Mycetes (2)	8·95		9·65		*Mycetes*	92·75	
	Lagothrix (2)...	9·1		9·65		*Ateles*	94·3	
	Ateles (4)	14·5		15·8		*Lagothrix*	94·35	
Simiidae	*Cercopithecus* (8)	9·2	Mean 12·53	9·5	Mean 13·12	*Cercocebus*	92·75	Mean 96·18
	Macacus (14)...	12·3		12·9		*Cynocephalus*	94·9	
	Semnopithecus (10)	12·5		12·6		*Macacus*	96·4	
	Cercocebus (4)	13·25		14·3		*Cercopithecus*	96·65	
	Cynocephalus (8)	15·4		16·3		*Semnopithecus*	100·2	
	Dryopithecus rhenanus ...	18·4		20·1			91·5	
Simiinae	Gibbon (2)	9·0		10·75		Orang-utan	74·7*	* Mean 81·13
	Orang-utan (5)	15·1	Mean 21·99	20·3	Mean 26·86	Gibbon	83·7	
	Chimpanzee (2)	21·95		26·2		Chimpanzee	83·8*	
	Gorilla ♂ (4)...	31·7 } 28·91		37·0 } 34·09		Gorilla ♂	85·65 } 84·9*	
	„ ♀ (3)...	25·2		30·2		„ ♀	83·9	
	Pithecanthropus erectus ...	31·2?		33·2			94·0?	
Hominidae	Neanderthal Type (7) ...	26·4	Mean 26·77	34·1	Mean 33·98		77·6	Mean 78·42
	Galley Hill (1)	23·8		35·7			66·7	
	Cromagnon Type (5) ...	28·7		39·5			73·0	
	Grimaldi Type (2)	31·0		35·0			82·8	
	Homo aurignacensis (*Haus.*) (1)	25·5		29·5			86·4	
	Recent Man (17th century Londoners) ♂	26·74 } 25·2		31·60 } 30·1			85·22 } 84·0	
	♀	23·58		28·63			82·87	

division of the Lemuroids into Tarsiidean and Lemurine groups by no means holds for this character owing to the position of the true lemurs[1]. Further, the femur of the lemur actually gives one on handling the impression of platymery. We think the real source of these discrepancies arises from the platymeric section being taken in the subtrochanteric region. The flattening which occurs in certain genera is at the level of or even above the second trochanter rather than below it, and this fact was overlooked when it was settled to take for Man the index in the *subtrochanteric* region. However, as far as general means go, we see that the platymery remains much the same for the *Cebidae* as for the *Lemuroidea*, but decreases markedly with the *Simiadae* with a Platymeric Index of 96·18, an approximately rotund section. Then we come to the Greater Anthropoids with a most marked increase of platymery, the index sinking to 81·13, which is not very far from that of the Recent Gibbon, and is far below that of the *Lemuroidea*. What interpretation can we put on this? It is a change directly opposite in direction to that of the *Simiadae*. If we look to *Dryopithecus rhenanus* for light we see that the Recent Gibbon is more platymeric than the fossil, which has retained much the value found in the Lemuroids or the *Cebidae*. Thus it would appear that *Simiadae* and *Simiinae* have followed quite opposite directions; their common ancestors probably started with an index of about 90 to 91. On the one hand the *Simiadae* increased relatively their antero-posterior diameter, on the other the *Simiinae* increased relatively their transverse diameter, as the following summary roughly indicates:

Increase on Lemuroid Values.

	Antero-posterior Diameter	Transverse Diameter
Cebidae	37·0 °/o	36·0 °/o
Simiadae	119·8 °/o	105·3 °/o

Increase on *Cebidae* Values.

Simiadae	60·4 °/o	51·0 °/o
Simiinae	181·6 °/o	209·3 °/o

Increase on *Simiinae* Values.

Neanderthal Man	20·1 °/o	27·0 °/o
Recent Man	19·1 °/o	12·0 °/o

Now we see that while the change in the two diameters of the *Cebidae* on the Lemuroids was almost exactly equal, that of the antero-posterior diameter in the *Simiadae* was 14 °/o greater. Again, measuring increase from *Cebidae* values, the *Simiadae* have developed 9 °/o more rapidly in the antero-posterior and the *Simiinae* 28 °/o more rapidly in transverse diameter. In other words, it appears as if it were the rapid growth of transverse diameter in the *Simiinae* which has led to the greatly increased platymery. Lastly, when we come to the *Hominidae* we see that Neanderthal Man has maintained the Simiine tendency to develop the transverse diameter at a greater rate than the antero-posterior diameter, while Recent Man has reverted to the tendency of the *Simiadae* and has developed the antero-posterior more rapidly than the transverse diameter. The relatively greater growth of the transverse diameter is maintained in Cromagnon Man, but (judged on Neanderthal Man) practically ceases with Grimaldi Type, when the values of both diameters begin to fall, but the antero-posterior less rapidly than the transverse. Recent Man has fallen on Cromagnon Man much less in antero-posterior than in transverse diameter. The final result is that for this character he is definitely more like the Chimpanzee or Gorilla than Neanderthal Man was.

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[1] Nevertheless the means give us Tarsiidean Group 95·85 and Lemurine Group 87·32. For the *Cebidae* the Mycetean Group gives us 92·05 and the Nyctipithecine Group 88·35, so that as in the case of torsion (see our p. 323) the Mycetean is more closely related to the Tarsiidean and the Nyctipithecine to the Lemurine. On the other hand for this character the *Simiadae* approach closer to the Tarsiidean than to the Lemurine Group, which is not the general rule.

(*b*) *Diameters and Indices of the Pilastric Section.*

While the diameters of the first three Lemuroid genera show the same differentiation from the last three as in the case of the platymeric section, the high pilastric indices of the *Tarsiidae* and *Galaginae* are not supported by that of the *Lorisinae*[1]. The *Cebidae* show a moderate fall on the *Lemuroidea*, the *Simiadae* a slight fall, being thus less differentiated from the Lemuroids for this character than the *Cebidae*. But when we come to the Greater Anthropoids, the nearly rotund average femur of the *Lemuroidea* and the *Simiadae* is replaced by a very elliptic one owing to a great increase of the pilastric transverse diameter. The fall in the index of the Greater Anthropoids on the Lemuroid value is 20, and on the *Simiadae* value 19 points! This change does not denote a loss of pilaster so much as a change from a rotund to a maliform shape. At the same time there are more signs of incipient pilaster in some of the Macaques and Baboons than we find in the Greater Anthropoids. With the *Hominidae* comes again the swing of the pendulum, the pilastric transverse develops more rapidly than the antero-posterior, and the result is that the pilastric index in Recent Man agrees with that of *Macacus* and not with Greater Anthropoid values. In marked contrast to the other *Simiinae* is the Recent Gibbon, with a high pilastric index practically identical with that of the Neanderthal Type. Can we look upon this as really strengthening the argument for the hylobatic origin of Man? We think not, for: (i) we believe our small sample has given a fortuitously high value to this index: the value provided in our Table, p. 253, for 41 Recent Gibbons is only 97·1, and this agrees better with the value of the fossil *Dryopithecus* at 98·3. We cannot therefore consider the Recent Gibbon if it has a value much over 100 to have done more than Man has done, *i.e.* acquired it in recent times. (ii) Our own Recent Gibbons have not a high pilastric index because, like Man, they have a pilaster, *i.e.* a pyriform section, but because their section is elliptic with the longer axis in the antero-posterior direction. Thus even if the Recent Gibbon had the pilastric index the same as in Neanderthal Man, we cannot consider it an argument for hylobatic origin. Nor is *Pithecanthropus erectus* proved to be hylobatic

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[1] In much the same way the position of *Lagothrix*—the femur of which rarely misses a chance of being anomalous—upsets the Mycetean Group in the *Cebidae*.

TABLE XXIII. *Diameters and Indices of the Pilastric Section.*

	Group	Pilastric A.P. Diameter			Pilastric Transverse Diameter			Pilastric Index				Group	Index of Sagittal Slenderness			Index of Transverse Slenderness			
Lemuroidea	*Tarsiidae* (2)	3·45		Mean 5·78	2·9		Mean 5·73	*Tarsiidae*	115·7		Mean 102·42	*Tarsiidae*	5·6		Mean 6·30	*Tarsiidae*	4·85		Mean 6·22
	Galaginae (6)	4·0			3·65			*Galaginae*	111·3			*Indrisinae*	5·6			*Indrisinae*	5·5		
	Lorisinae (6)	4·4			4·9			*Indrisinae*	101·7			*Chiromyrdae*	6·4			*Chiromyrdae*	6·5		
	Chiromyrdae (2)	7·2			7·4			*Lemurinae*	99·0			*Lorisinae*	6·4			*Galaginae*	6·55		
	Indrisinae (8)	7·8			7·6			*Chiromyrdae*	97·3			*Lemurinae*	6·6			*Lemurinae*	6·7		
	Lemurinae (18)	7·8			7·9			*Lorisinae*	89·5			*Galaginae*	7·2			*Lorisinae*	7·2		
Cebidae	*Hapalinae* (16)	3·9		Mean 7·39	4·1		Mean 7·59	*Lagothrix*	107·75		Mean 97·46	*Brachyurus*	5·25		Mean 6·42	*Brachyurus*	5·1		Mean 6·58
	Nyctipithecinae (8)	4·45			4·7			*Brachyurus*	103·5			*Pithecia*	5·6			*Pithecia*	5·75		
	Cebus (6)	6·4			7·0			*Pithecia*	97·8			*Nyctipithecinae*	5·6			*Nyctipithecinae*	5·9		
	Pithecia (2)	6·55			6·7			*Hapalinae*	95·1			*Cebus*	6·1			*Cebus*	6·6		
	Brachyurus (2)	7·35			7·1			*Nyctipithecinae*	94·9			*Hapalinae*	6·6			*Hapalinae*	6·9		
	Lagothrix (2)	8·35			7·75			*Ateles*	94·8			*Mycetes*	6·7			*Mycetes*	7·1		
	Mycetes (2)	8·9			9·45			*Mycetes*	94·25			*Ateles*	6·8			*Ateles*	7·2		
	Ateles (4)	13·2			13·9			*Cebus*	91·6			*Lagothrix*	8·7			*Lagothrix*	8·1		
Simiadae	*Cercopithecus* (8)	9·7		Mean 12·79	9·7		Mean 12·66	*Macacus*	103·4		Mean 100·82	*Semnopithecus*	6·6		Mean 7·45	*Semnopithecus*	6·6		Mean 7·31
	Semnopithecus (10)	12·1			12·1			*Cynocephalus*	101·2			*Cercocebus*	6·8			*Cercocebus*	6·75		
	Macacus (14)	12·7			12·3			*Cercocebus*	100·7			*Cercopithecus*	7·6			*Cercopithecus*	7·4		
	Cercocebus (8)	13·45			13·35			*Semnopithecus*	99·5			*Cynocephalus*	7·9			*Cynocephalus*	7·8		
	Cynocephalus (8)	16·0			15·85			*Cercopithecus*	99·3			*Macacus*	8·35			*Macacus*	8·0		
	Dryopithecus rhenanus (1)	17·8			17·5				98·3			*Dryopithecus rhenanus*	7·0				6·9		
Siminae	Gibbon (2)	9·45		Mean 21·93	8·75		Mean 26·72	Gibbon	108·15		Mean 82·11	Gibbon	5·4		Mean 8·86	Gibbon	5·0		Mean 10·97
	Orang (5)	15·8			19·3			Gorilla ♂	81·9	81·4		Chimpanzee	8·3			Chimpanzee	10·5		
	Chimpanzee (2)	21·4			25·85			,, ♀	80·8			Orang	8·4			Orang	10·2		
	Gorilla ♂ (4)	31·5	28·6		38·3	35·0		Orang	82·1			Gorilla ♂	10·1	9·9		Gorilla ♂	12·35	12·2	
	,, ♀ (3)	24·7			30·6			Chimpanzee	82·8			,, ♀	9·6			,, ♀	11·9		
	Pithecanthropus erectus (1)	30·0			27·6				108·7			*Pithecanthropus erectus*	7·6				7·0		
Hominidae	Neanderthal Type	30·5		Mean 30·23	28·2		Mean 27·54		108·1		Mean 109·88	Neanderthal Type	8·4		Mean 7·82		7·8		Mean 7·13
	Galley Hill	26 2			26·4				99·2			Galley Hill	7·3				7·3		
	Cromagnon Type	38·6			30·0				125·1			Cromagnon Type	[8·2]				6·4		
	Grimaldi Type	—			29·0				—			Grimaldi Type	—				7·1		
	H. aurignacensis (*Hauseri*)	28·5			25·0				114·0			*H. aurignacensis* (*Hauseri*)	7·7				6·8		
	Recent Man (17th century Londoners) ♂	29·11	27·36		27·99	26·63			104·43	103·02		Recent Man (17th century Londoners) ♂	7·71	7·54			7·43	7·35	
	♀	25·61			25·28				101·61			♀	7·36				7·28		

because it has a Recent Gibbon (and therefore a Recent Man) value of the pilastric index. The problem can only be answered when we have a drawing of the pilastric section and know whether it is pyriform or elliptic[1]. But if the section be non-pyriform, then we ought to compare the pilastric index of *Pithecanthropus* (108) with *Dryopithecus* (98) and the agreement here is far less than with the *Hominidae*.

We doubt, however, whether in this case—any more than in the case of the platymeric section—it is the index which is of primary evolutionary importance. The Greater Anthropoids developed along the direction of increasing pilastric transverse, we suspect because their gait made the transverse plane that of maximum femoral stress. This was pressed to the extreme in the gorilla. Assuming that man had a more chimpanzee-like than gorilloid progenitor, this development of transverse growth continued through Neanderthal to the Cromagnon type, but with rapidly decreasing intensity. On the other hand the development of the antero-posterior diameter quickened up, and reached its maximum in Cromagnon Man, but the result was not obtained as in the lower primates chiefly by developing a rotiform into an oval cross-section, but by superposing on the fairly rotiform shaft a massive pilaster and so producing a pyriform section. We suspect that Neanderthal Man walked with not a little of an anthropoid gait. How came man with the Cromagnon type to the exaggerated pilaster which more than solved the problem of uprightness? We have not the requisite series—if they existed—of intermediate links to solve the problem, and even the Galley Hill femur, which has partly aided us on other occasions, fails us here owing to the defective condition of its pilastric region. Cromagnon may have been a saltatory mutation, but if so a mutation not only of bones, but of an elaborate musculature, not only correlated together, but correlated with an almost new and most advantageous method of progression! It is difficult to believe in such a saltatory mutation occurring fortuitously and one looks with confidence to the ultimate discovery of types intermediate between Cromagnon (or indeed Recent) Man and Neanderthal (or indeed, if that be treated as a branch line, Troglodytic) Man.

Summary of results just indicated:

	Pilastric Antero-posterior Diameter	Pilastric Transverse Diameter	Ratio
Cebidae on *Lemuroidea*	27·9 °/o	32·5 °/o	0·86
Simiadae on *Lemuroidea*	121·3 °/o	120·9 °/o	1·00
Chimpanzee on *Simiadae*	71·5 °/o	104·2 °/o	0·69
Neanderthal Man on Chimpanzee	42·5 °/o	9·1 °/o	4·67
Cromagnon Man on Chimpanzee	80·4 °/o	16·1 °/o	4·99
Recent Man on Chimpanzee	27·9 °/o	3·0 °/o	9·30

Thus while relative to the *Lemuroidea*, the *Simiadae* had practically equal development of both diameters, the Chimpanzee shows a greatly preponderating growth of the transverse diameter, emphasising the tendency in this direction of the *Cebidae*. The *Hominidae* all show on the other hand a preponderating development on the Chimpanzee values of the antero-posterior diameter, and although the two diameters for Recent Man are both less than those for either type of Primogenial Man, still the relative rate of growth—the ratio of the percentage increases—has continued in one sense, and in Recent Man is nearly double that for Neanderthal Man.

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[1] The drawings of the Trinil femur seem to indicate at least some pilastric development.

The indices of slenderness are attached to the table on p. 328 to indicate the manner in which the pilastric diameters have changed relatively to the length of the shaft. We see at once that for *Cebidae*, *Simiadae* and *Simiinae* the orders of slenderness, sagittal and transverse, are absolutely the same. They are very nearly the same for the *Lemuroidea* the only change being that of the *Galaginae* and *Lorisinae* in the last three genera. Further the degree of slenderness is very nearly the same transversely and sagittally, for *Lemuroidea*, *Cebidae* and *Simiadae*. It is markedly unequal in the *Simiinae*, but has been partially, if not wholly, restored in Recent Man. The *Cebidae* show only a very slight decrease in slenderness on the *Lemuroidea*; the *Simiadae* advance a point, but the Greater Anthropoids advance 2½ points in sagittal, 4½ points in transverse, slenderness on the Lemuroids. The Recent Gibbon is almost as slender as *Tarsius*, while *Dryopithecus rhenanus* agrees with *Ateles*. With Man we find a reversion to the *Simiadae*, and here as in a number of other characters to which we have drawn attention the *Hominidae* are closer in their most recent forms to the monkeys than to the Anthropoids. The protsimio-human will for both indices of slenderness probably have a value of 8 to 9 and the most like him of the *Simiinae* will undoubtedly be the Chimpanzee.

(c) *Diameters and Indices of the Popliteal Section.*

This third fundamental section largely confirms what we have learnt from the earlier two. We can summarise as follows the development of the diameters:

Rates of Increase of Popliteal Diameters.

	Antero-posterior Diameter	Transverse Diameter	Ratio
Cebidae on *Lemuroidea*	27·4 °/。	46·6 °/。 ...	0·59
Simiadae on *Lemuroidea*	128·5 °/。	129·4 °/。 ...	0·99
Greater Anthropoids on *Simiadae*	76·1 °/。	134·8 °/。 ...	0·56
Neanderthal Man on Chimpanzee	36·0 °/。	17·3 °/。 ...	2·08
Cromagnon Man on Chimpanzee	56·5 °/。	32·8 °/。 ...	1·72
Recent Man on Chimpanzee ...	11·7 °/。	10·0 °/。 ...	1·17

It will be seen from this that in the New World monkeys there was a greater rate of development of the transverse diameter, but that in the Old World monkeys the developments of both diameters were nearly equal. With the Greater Anthropoids it is the transverse diameter which is emphatically developed. But with the *Hominidae* comes a change; the greater development is now in the antero-posterior diameter, and the increase is very considerable in the ratio from Greater Anthropoids to Neanderthal Man; Cromagnon carries on the tendency if less markedly than Neanderthal, but with Recent Man comes a fall in this tendency of a marked character, probably resulting from the progress towards flat and concave popliteal areas, checking the development of the antero-posterior diameter. It should be noted that for all three fundamental sections of the femur the antero-posterior diameter has developed at a greater rate in the *Hominidae* and the transverse diameter in the Greater Anthropoids. The development of the latter in the Greater Anthropoids has always been relatively greater than in the *Simiinae.* The result is that pilastric, platymeric and popliteal indices all show low values for the Greater Anthropoids, and a rise again in Man. But this rise again of the indices does not indicate a fall of the human transverse diameters below that of the apes. Those diameters continue to increase, but at a rate relatively slow compared with the quickened rate of the antero-posterior development. Judged from the standpoint merely of the indices it looks like a regression of Man, especially of Recent Man, to a more apelike character; Man is frequently found to stand between *Simiinae* and *Simiadae.* But looked at from the standpoint of developing diameters we may interpret the changes in the following manner: the Greater Anthropoids exhibit a strong tendency to increase of transverse diameter,

TABLE XXIV. *Diameters and Index of Popliteal Section.*

	Group	Popliteal A.-P. Diameter		Popliteal Transverse Diameter		Popliteal Index		
Lemuroidea	*Tarsiidae* (2)	3·15	Mean 5·43	3·05	Mean 6·78	*Tarsiidae*	106·6	Mean 82·79
	Galaginae (6)...	4·0		4·5		*Galaginae*	87·2	
	Lorisinae (6)	4·1		6·85		*Lemurinae*	84·2	
	Chiromyrdae (2)	6·8		8·85		*Indrisinae*	81·6	
	Indrisinae (8)	7·1		8·6		*Chiromyrdae*	76·85	
	Lemurinae (18)	7·4		8·8		*Lorisinae*	60·3	
Cebidae	*Hapalinae* (16)	3·8	Mean 6·92	5·0	Mean 9·94	*Hapalinae*	76·1	Mean 70·58
	Nyctipithecinae (8)	4·5		6·45		*Mycetes*	74·35	
	Pithecia (2)	5·55		7·5		*Pithecia*	74·1	
	Cebus (6)	6·1		8·8		*Nyctipithecinae*	70·2	
	Brachyurus (2)	6·35		9·45		*Cebus*	69·6	
	Mycetes (2)	8·25		11·1		*Brachyurus*	67·25	
	Lagothrix (2)	8·25		12·4		*Lagothrix*	66·55	
	Ateles (4)	12·55		18·8		*Ateles*	66·5	
Simiadae	*Cercopithecus* (8)	9·4	Mean 12·41	12·0	Mean 15·55	*Cercocebus*	84·7	Mean 80·22
	Semnopithecus (10)	11·8		15·2		*Macacus*	82·8	
	Macacus (14)...	12·5		15·3		*Cercopithecus*	79·3	
	Cercocebus (4)	12·85		15·15		*Semnopithecus*	77·3	
	Cynocephalus (8)	15·5		20·1		*Cynocephalus*	77·0	
	Dryopithecus rhenanus (1) ...	16·0		25·2			63·5	
Simiinae	Gibbon (2)	8·65		11·1			78·2	
	Orang-utan (5)	16·7	Mean 21·85	25·4	Mean 36·45		65·9	Mean 61·84
	Chimpanzee (2)	23·45		34·35			68·25	
	Gorilla ♂ (4)...	27·95 } 25·40		54·7 } 49·6			51·1 } 51·36	
	,, ♀ (3)...	22·0		42·9			51·7	
	Pithecanthropus erectus ...	32·0		36·0			88·9	
Hominidae	Neanderthal Type	31·9	Mean 31·96	40·3	Mean 41·32		79·4	Mean 75·80
	Galley Hill	31·0		44·8			69·2	
	Cromagnon Type	36·7		45·6			81·0	
	Grimaldi Type	34·0		45·0			80·0	
	Homo aurignacensis (*Hauseri*)	—		[34·4]			—	
	Recent Man (17th century Londoners) ♂	27·97 } 26·2		39·65 } 37·8			70·84 } 69·4	
	♀	24·33		35·90			67·92	

the gain was not lost by the *Hominidae*, but they supplemented it by a pronounced increase of antero-posterior diameter. This growth as far as the pilastric section is concerned is associated with the development of the pilaster, but that is not its sole source for both platymeric and popliteal antero-posterior diameters have also developed largely at the same time; and clearly without such development the pilaster would be of small service[1].

The Popliteal Index of *Dryopithecus rhenanus* carries us back to something like the Greater Anthropoid type, while that of the Recent Gibbon (78·2 for our slender material and 81·4 for 41 individuals, see our table, p. 253) is either recent advance like that of Man, or indicates that the Recent Gibbon cannot claim an ancestor of the *Dryopithecus rhenanus* type and must be placed outside the *Simiinae*. The Gibbon, however, is in so many characters associated with *Ateles*-like forms, that we prefer the former hypothesis, and believe its ancestors to have passed through a low value of the index.

(*d*) *Indices of Popliteal Shape. Soffit Index and Index of Popliteal Skewness.*

There are two further indices of the popliteal area which are tabulated below, namely the Soffit Index and that of Popliteal Skewness. We have indicated on pp. 10, 306–7 and Chapter X the source and the proposed aim of these indices. Taking the second index first into consideration, we see that if Manouvrier's view were correct, the convexity of the popliteal surface in the Tarsiidean group of the Lemuroids would be about that of Neanderthal Man, and that the index fell in both New and Old World monkeys, somewhat more, however, in the former. It fell very rapidly again in the Greater Anthropoids, notably in the gorilla. For the *Hominidae* Neanderthal Man started with the Lorisine value and it has fallen with extreme rapidity to a value in Recent Man only paralleled by that of the Hapalinae and exceeded by that of *Dryopithecus rhenanus*. We believe that the latter value must be regarded as anomalous, it is too remote from both *Ateles* and the Recent Gibbon, and the position of *Dryopithecus* for this index links up with no other kindred form, and is totally out of keeping with the value which we might suppose the ancestors of the *Simiinae* to have taken.

Some explanation is needed of the startling change between the Greater Anthropoids and Neanderthal Man in the value of this index. As a matter of fact Neanderthal Man has a more convex popliteal surface than even the Anthropoids. A glance at our tracings in Chapter X of the popliteal section in Primogenial Man and the Anthropoids shows at once that Neanderthal Man in lessening absolutely his popliteal width compared with that of the gorilla has increased absolutely his direct antero-posterior diameter, *i.e.* what he has lost transversely he has fully replaced sagittally; the result is that his popliteal surface is more convex than that of the gorilla and his oblique popliteal antero-posterior not only became less than that of the gorilla, but shorter

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[1] This correlated development could hardly be the product of muscular action, and its existence is a good argument against those who attribute the development of the pilaster to muscular action. The problem whether bone growth produced muscular attachment or muscular attachment bone growth seems allied to the older problem of which, hen or egg, is the source of the other, and indeed admits of the same answer.

TABLE XXV. *Indices of Popliteal Shape; Soffit Index and Index of Popliteal Skewness.*

	Group	Soffit Index			Group	Index of Popliteal Skewness		
Lemuroidea	*Tarsiidae* (2)	44·2		Mean 50·21	*Tarsiidae*	121·15	111·35	Mean 103·63
	Chiromyrdae (2)	47·6			*Lorisinae*	111·7		
	Indrisinae (8)	49·4			*Galaginae*	101·2		
	Lemurinae (18)	49·8			*Indrisinae*	99·7	95·9	
	Galaginae (6)	52·8			*Chiromyrdae*	95·8		
	Lorisinae (6)	57·45			*Lemurinae*	92·2		
Cebidae	*Mycetes* (2)	43·20		Mean 49·01	*Mycetes*	110·75		Mean 99·14
	Cebus (6)	44·3			*Pithecia*	100·9		
	Pithecia (2)	44·65			*Lagothrix*	100·6		
	Brachyurus (2)	47·45			*Cebus*	99·3		
	Nyctipithecinae (8)	49·1			*Brachyurus*	99·2		
	Hapalinae (16)	49·6			*Nyctipithecinae*	96·5		
	Lagothrix (2)	56·35			*Ateles*	95·0		
	Ateles (4)	57·45			*Hapalinae*	90·9		
Simiadae	*Cercocebus* (4)	51·35		Mean 52·92	*Macacus*	101·9		Mean 97·35
	Macacus (14)	52·3			*Cercopithecus*	99·9		
	Semnopithecus (10)	52·6			*Cynocephalus*	96·5		
	Cercopithecus (8)	53·25			*Semnopithecus*	94·8		
	Cynocephalus (8)	55·1			*Cercocebus*	93·65		
	Dryopithecus rhenanus (1)	61·3			*Dryopithecus rhenanus*	88·9		
Simiinae	Gibbon (2)	43·95			Gibbon	100·6		
	Chimpanzee (2)	49·55		Mean 53·03	Orang-utan	97·7		Mean 89·54
	Orang-utan (5)	50·9			Chimpanzee	93·35		
	Gorilla* ♂ (4)	59·1	58·63		Gorilla ♂	75·5	77·56	
	,, ♀ (3)	58·0			,, ♀	80·3		
	Pithecanthropus erectus (1)	46·2			*Pithecanthropus erectus*	—		
Primogenial Man	Neanderthal Type (1)	45·8		Mean 48·38	Neanderthal Type	107·6		Mean 106·35
	Galley Hill (1)	[50·9??]			Galley Hill	105·1		
	Cromagnon Type (5)	51·5			Cromagnon Type (2)	97·3?		
	Grimaldi Type (2)	48·4			Grimaldi Type	—		
	H. aurignacensis (*Hauseri*) (1)	45·3			*H. aurignacensis* (*Hauseri*)	—		
Recent Man	17th century Londoners ♂	49·99	50·42		17th century Londoners ♂	90·96	90·76	
	,, ,, ♀	50·86			,, ,, ♀	90·57		

* The reader must remember that all the apes here are of our own measuring. The seven gorillas in this table are not therefore identical with the seven in the second table of Chapter X, the measurements of two of which were taken as there stated from other authors' works. Since that table was printed off the Laboratory has acquired further gorilla bones. Sometimes the reader will find that in special tables we deal with more specimens than are given in the large table of measurements of apes in the Atlas, Part II. This arises from the fact that femora of Anthropoids have been lent to us occasionally for short periods, and were used for any tables which were at that time in preparation.

than his direct diameter. He got in fact a more rotund shaft in the popliteal region. We are inclined to believe that this arose from a transfer of the plane of maximum bending moment from a transverse plane in the case of the troglodyte femur to a nearly sagittal plane in the case of the human femur. If we are to suppose such a value of the index of popliteal skewness to have long existed in the ancestors of Neanderthal Man, we should have to pass by even *Macacus* and form our link to the main primate line with something like *Mycetes* or even further back with the *Lorisinae*. The fact that this high index of popliteal skewness vanishes almost suddenly[1] suggests that it had not been long acquired and would not probably be found in the protsimio-human.

The Soffit Index is seen from the present table to have a singularly constant value in each of the great primate families. It falls but one point from Lemuroids to *Cebidae*. It rises three points from Lemuroids to *Simiadae*, whose value is essentially the same as that of the Greater Anthropoids. In Primogenial Man the value appears to be low for Neanderthal Man, but to have risen to the Recent Man value with Cromagnon or slightly exceeded it; that value itself is precisely what we started with, that of the Lemuroids. The value of *Dryopithecus rhenanus* is now exceptional but it receives some support from *Ateles*. The low value of the Recent Gibbon is anomalous, linking up with neither *Simiinae*[2] nor *Simiadae*; in fact we have to go back to the *Cebidae* to find a parallel in *Mycetes*. It represents, however, the same feature as Klaatsch found in the Neanderthal Type, namely the more or less rapid drawing in of the shaft just above the condyles. Is it an argument for the hylobatic as opposed to a troglodytic ancestry for Man? We believe not, because we hold it to be—judging from *Dryopithecus rhenanus*—a recent acquirement of the Gibbon. From this standpoint also the Trinil femur is seen to be human, lying between Neanderthal and Recent Man, and not that of a *Hylobates giganticus*, to which our nearest approach, short of pure hypothesis, must be the Eppelsheimer femur. Since the actual popliteal width of Neanderthal is greater than that of the mean Greater Anthropoids, we see that the fall in the Soffit Index is solely due to a greater development of the bicondylar width, especially of the epicondyles.

VIII. INDICES OF GRACILITY AND TAPER OF THE SHAFT OF THE PRIMATE FEMUR.

(a) *Indices of Gracility.*

(i) The proximal gracility is here measured by the ratio of the pilastric transverse to the platymeric transverse; it is thus a measure of the relative thinning down—hour glass shape—of the centre of the shaft. We see that the proximal gracility of the *Cebidae* is only two points greater than that of the Lemuroids. The *Simiadae* have a gracility which is six points less and this reduction is continued in the Greater Anthropoids so as to be eight points less. In the gorilla indeed it is twelve points less and he actually attains a maximum of shaft strength by an index of gracility over 100, in this being only comparable with *Cercopithecus.* Both therein resemble the Greek column with a slightly greater mid-diameter, *i.e.* barrel, not hour glass shape. With Man the development of the pilaster gave that strength to his femoral strut, which the gorilla had sought by his barrel shaft, and the result was a return to gracility which reached its maximum in the exaggeratedly pilastered Cromagnon, but has fallen considerably in Recent Man, who stands close to the *Cebidae* level. In other words for this character Man has the appearance of reverting to a value more primitively apelike than the *Simiadae.*

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[1] Note that our cast value for Cromagnon is back at the *Simiadae* value.

[2] This view would not be correct if we could accept without reserve the four values (44·4, 44·4, 42·9, 42·1) obtained from Hepburn's measurements on two chimpanzees. But he has taken the popliteal width by the 4 cms. rule on femora of oblique lengths 298·5 and 260·5 cms. These oblique lengths must correspond roughly to diaphysial lengths of 251·3 and 219·3 cms. Thus according to our rule for the apes they should have been taken at 2·51 and 2·19 cms. and not 4 cms. from the patellar surface border. Accordingly the popliteal widths and therefore the soffit indices would be very much higher than the above values. We find that to drop the popliteal section 2 cms. raises the popliteal width in the chimpanzee about 11 °/ₒ or Hepburn's values of the popliteal width in his chimpanzees would need increasing by 8·25 and 9·9 cms., giving values 48·1, 48·1, 47·1 and 46·3 in much closer accordance with ours.

Noteworthy in this respect is the position of the Recent Gibbon. It has gained gracility not by developing a pilaster, but by the development of an oval mid-section to the shaft. The Recent Gibbon has far more proximal gracility than *Dryopithecus rhenanus*, which stands at the level of Recent Man and the *Cebidae* (87 to 88). Thus again we are forced to consider the femur of *Hylobates* as differentiating it very markedly from the Greater Anthropoids, and hardly less from the *Simiadae*; it finds its nearest comparatives in the *Cebidae.* This may be merely a resemblance produced by an evolution towards greater agility,—and the Eppelsheimer femur carries us nearer a stage of less gracility,—or it may point to a line of descent for *Hylobates* with a branch point below that of the *Simiadae.*

(ii) The index of distal gracility is measured by the ratio of the pilastric to the popliteal transverse. We see that the index falls continuously (more rapidly in *Cebidae* than *Simiadae*) as we pass from the Lemuroids right up to Recent Man. Thus we see that the evolution of the primate femur has been one in which the shaft treated as a column had a steadily increasing development above the pediment relative to the central development, *i.e.* the trumpet or Eifel Tower form has been continuously emphasised. This is one of the few indices in which the Greater Anthropoids stand as intermediates between the *Simiadae* and Man, if indeed we ought not to say that Recent Man—and he differs very little from Primogenial Man—is not in distal gracility perfectly gorilloid.

Again we see the Recent Gibbon differentiated from the Anthropoids, and still more from the fossil *Dryopithecus*, which in this character is thoroughly human. *Pithecanthropus erectus* is now closer to the Anthropoids than to the *Hominidae*, but he is far from our nearest approach to the hypothetical *Hylobates giganticus*[1].

(*b*) *Indices of Taper.*

(i) *Index of Proximal Taper.* Proximal Taper is measured by the ratio of the platymeric to the pilastric antero-posterior diameter. When the index is over 100 it means that sagittally the shaft is thicker proximally than at the mid-section, when it is

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[1] Here again the argument from a single character in a single individual of the race is of very little worth. Our range of variation of the index of distal gracility in Recent Man runs from 58 to 92 and the Trinil femur is 77!

TABLE XXVI. *Indices measuring the Gracility and Taper of the Femoral Shaft in the Primates.*

	Gracility						*Taper*					
	Group	Index of Proximal Gracility		Group	Index of Distal Gracility		Group	Index of Proximal Taper		Group	Index of Distal Taper	
Lemuroidea	*Tarsiidae* (2)	83·3	Mean 90·43	*Tarsiidae*	95·05	Mean 84·61	*Tarsiidae*	89·9	Mean 99·05	*Indrisinae*	91·7	Mean 94·67
	Chiromyrdae (2)	87·1		*Lemurinae*	89·7		*Chiromyrdae*	96·6		*Lorisinae*	92·6	
	Lemurinae (18)	89·0		*Indrisinae*	88·3		*Indrisinae*	98·2		*Tarsiidae*	94·2	
	Indrisinae (8)	89·0		*Chiromyrdae*	83·6		*Galaginae*	102·2		*Chiromyrdae*	94·4	
	Galaginae (6)	94·85		*Galaginae*	79·4		*Lorisinae*	103·0		*Lemurinae*	96·2	
	Lorisinae (6)	99·35		*Lorisinae*	71·6		*Lemurinae*	104·4		*Galaginae*	98·9	
Cebidae	*Lagothrix* (2)	80·35	Mean 87·97	*Pithecia*	89·45	Mean 77·86	*Mycetes*	100·55	Mean 105·38	*Pithecia*	84·75	Mean 93·91
	Brachyurus (2)	81·6		*Mycetes*	85·15		*Hapalinae*	101·3		*Brachyurus*	86·45	
	Nyctipithecinae (8)	84·8		*Hapalinae*	82·2		*Pithecia*	102·25		*Mycetes*	92·7	
	Cebus (6)	87·4		*Cebus*	79·6		*Brachyurus*	104·75		*Ateles*	94·4	
	Pithecia (2)	88·25		*Brachyurus*	75·2		*Nyctipithecinae*	106·4		*Cebus*	95·7	
	Ateles (4)	90·5		*Ateles*	74·85		*Cebus*	108·7		*Hapalinae*	97·7	
	Hapalinae (16)	92·9		*Nyctipithecinae*	73·9		*Lagothrix*	109·05		*Lagothrix*	98·8	
	Mycetes (2)	98·0		*Lagothrix*	62·5		*Ateles*	110·0		*Nyctipithecinae*	100·8	
Simiadae	*Cercocebus* (4)	93·35	Mean 96·88	*Cercocebus*	88·2	Mean 81·70	*Cercopithecus*	94·2	Mean 98·56	*Cercocebus*	95·4	Mean 97·80
	Semnopithecus (10)	95·65		*Cercopithecus*	81·65		*Cynocephalus*	96·5		*Cynocephalus*	96·9	
	Macacus (14)	95·7		*Macacus*	80·7		*Macacus*	97·7		*Cercopithecus*	97·9	
	Cynocephalus (8)	97·3		*Semnopithecus*	79·1		*Cercocebus*	98·7		*Macacus*	99·0	
	Cercopithecus (8)	102·4		*Cynocephalus*	78·85		*Semnopithecus*	105·7		*Semnopithecus*	99·8	
	Dryopithecus rhenanus (1)	87·1		*Dryopithecus rhenanus*	69·4		*Dryopithecus rhenanus*	105·3		*Dryopithecus rhenanus*	89·9	
Simiinae	Gibbon (2)	81·35		Gibbon	78·95		Gibbon	95·2		Gibbon	91·5	
	Orang (5)	95·3	Mean 98·59	Orang	76·1	Mean 74·06	Orang	95·6	Mean 99·88	Gorilla ♂	89·4 } 89·31	Mean 101·52
	Chimpanzee (2)	98·7		Chimpanzee	75·25		Gorilla ♂	101·3 } 101·69		,, ♀	89·2	
	Gorilla ♂ (4)	103·65 } 102·77		Gorilla ♂	70·1 } 70·83		,, ♀	102·2		Orang	105·7	
	,, ♀ (3)	101·6		,, ♀	71·8		Chimpanzee	102·35		Chimpanzee	109·55	
	Pithecanthropus erectus (1)	83·1		*Pithecanthropus erectus*	76·7		*Pithecanthropus erectus*	104·0??		*Pithecanthropus erectus*	106·7??	
Primogenial Man	Neanderthal Type (7)	82·4	Mean 82·18	Neanderthal Type	70·3	Mean 71·38	Neanderthal Type	87·2	Mean 84·5	Neanderthal Type	105·5	Mean 96·4
	Galley Hill (1)	[73·9]*		Galley Hill	[58·9]*		Galley Hill	[90·8]*		Galley Hill	[118·3]*	
	Cromagnon Type (5)	79·3		Cromagnon Type	72·0		Cromagnon Type	76·8		Cromagnon Type	87·3	
	Grimaldi Type (2)	82·3		Grimaldi Type	70·5		Grimaldi Type	—		Grimaldi Type	—	
	H. aurignacensis (*Hauseri*) (1)	84·7		*H. aurignacensis* (*Hauseri*)	72·7		*H. aurignacensis* (*Hauseri*)	89·5		*H. aurignacensis* (*Hauseri*)	—	
Recent Man	17th century Londoners ♂	88·83 } 88·72		17th century Londoners ♂	71·04 } 70·87		17th century Londoners ♂	91·92 } 92·02		17th century Londoners ♂	95·97 } 95·97	
	,, ,, ,, ♀	88·61		,, ,, ,, ♀	70·70		,, ,, ,, ♀	92·12		,, ,, ,, ♀	95·98	

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* All these indices involve the pilastric diameters, which owing to weathering or other cause appear to us quite unreliable in the case of this femur. These values are accordingly omitted from the means for Primogenial Man.

under 100 the greater thickness is at the mid-section. The latter is the case in the *Hominidae* and we may describe it as *taper proper*; the former is the case for every genera of the *Cebidae* and we may speak of it as *reversed taper*. Taper proper exists in every genus of the *Simiadae* except *Semnopithecus*, and although not as great as in Man serves to differentiate the Old World from the New World monkeys. The genera of the Lemuroids are equally divided, *Tarsiidae*, *Chiromyrdae* and *Indrisinae* have taper proper, while *Galaginae*, *Lorisinae* and *Lemurinae* have reversed taper, thus indicating that variation within the Lemuroid genera practically covers the two classes of taper found in *Cebidae* and *Simiadae*. Turning to the *Simiinae* we see that Gorilla and Chimpanzee follow the *Cebidae* or indeed *Semnopithecus* in showing reversed taper, while the Gibbon and the Orang show taper proper, which is characteristic of the bulk of the genera of *Simiadae*. Turning to the *Hominidae* we note that Neanderthal Man shows a taper proper (87·2) scarcely equalled by that of *Tarsius* (89·9). In the case of Cromagnon Man owing to the development of pilaster in its exaggerated form the proximal taper sinks to 76·8, to rise again, however, in Recent Man to a value (92·0) still below that of all the primate genera discussed except *Tarsiidae*. Putting aside the *Cebidae*, there is but small change in taper from Lemuroids to *Simiinae*, then we have with Primogenial Man the marked fall of 15 points, with an ultimate rise in Recent Man to a value more apelike than in the case of Primogenial Man. It is the case we have so repeatedly noticed of Man being nearer to the lesser apes—in this case the *Simiadae*—than to the *Simiinae*. And this change may again be accounted for either by suggesting that the branch point of the *Hominidae* was lower on the parent stem than the branch point of the *Simiinae*, or by supposing that there has been a special source, *e.g.* the development of pilaster—which has increased the taper proper of the *Hominidae*. If we search for light from *Hylobates*, we see that the fossil *Dryopithecus rhenanus* starts with an amount of reversed taper (105·3), which can only be paralleled by *Semnopithecus* and is more characteristic of the *Cebidae* than of Anthropoids or Old World monkeys. Further we note that this taper has fallen by 10 points in the Recent Gibbon; it is therefore not so inconceivable that a protsimio-human with a taper of about 100—well within the range of the Greater Anthropoids—might lead to a Neanderthal Man of 13 points taper difference, certainly to a Recent Man with only 8 points difference. Of course the development would be simpler if we could give the protsimio-human a value more orangoid than chimpanzee-like. But the high value of the Eppelsheimer femur is rather against this unless we dismissed Hylobates altogether from our Anthropoid series, which we personally should not be sorry to do on the marked evidence of the femur, if one bone only were adequate to settle such a point.

(ii) *Index of Distal Taper*. Distal taper is measured by the ratio of the popliteal to the pilastric antero-posterior diameter. The index ascends, or taper lessens, continuously from Lemuroids through the *Simiadae* to the *Simiinae*; indeed it may be said to increase until it reaches reversed taper in the Orang, Chimpanzee and Neanderthal Man. The latter is therefore closer to the Chimpanzee than to Hylobates, the fossil and recent forms of which are close together, and gorilloid rather than chimpanzee-like. The fall from Chimpanzee to Gorilla is parallel to the fall from Neanderthal Man to Cromagnon, but is not due to the same cause—the development of the pilaster. The recovery from Cromagnon to Recent Man as usual results in placing the latter nearer to the mean of *Simiadae* than to the mean of the Greater Anthropoids.

IX. Proximal and Distal Breadth Ratios for the Primate Femur.

The discussion of these ratios forms a not inappropriate transition to the topics of the following chapters, which deal with the epiphyses of the femur of the primates. The question they may be supposed to answer is: How have the proximal and distal epiphyses developed relative to the absolute size of the femur, this absolute size being measured at Klaatsch's suggestion by the trochanteric length?

Clearly relative to this standard the proximal breadth increased from *Lemuroidea* to *Cebidae* very slightly, from *Lemuroidea* to *Simiadae* rather more, from *Simiadae* to Greater Anthropoids immensely. Neanderthal Man maintains without sensible increase the Greater Anthropoid value, being three points more than the Chimpanzee and two less than the Gorilla. From Neanderthal there is a drop to Cromagnon, which has a value close to that of Recent Man.

For the Gibbon series we have *Dryopithecus rhenanus* 17·6, Recent Gibbon 15·0, and for comparison *Ateles* 16·0, all values less than the mean value of the *Simiadae*. In the face of such evidence, it is very difficult to accept a hylobatic in preference to a troglodyte ancestry for Man. It is no less difficult to group the Gibbon with the Anthropoids; to do so is to accept a range of 12·5 in the genera of the *Simiinae*, as against 3·2 in the *Simiadae*, 4·0 in the *Cebidae* and 4·4 in the *Lemuroidea*. Roughly the intergeneric variability decreases as we rise in the scale, and a range of 12·5 seems wholly out of place.

Turning now to the Distal Breadth Ratio, we see that relative to the femoral length the distal epiphysis has increased about 2 points from the Lemuroids to the Monkeys, rather more in the *Cebidae* and less in the *Simiadae*. Then comes the great jump of 8 points from *Simiadae* to Greater Anthropoids. This jump is not wholly maintained in the *Hominidae*, the Neanderthal Type having a distal breadth ratio less than the Chimpanzee by about 0·5 points. From Neanderthal Man the fall is considerable through Cromagnon to Recent Man, due chiefly to the great development of shaft which the acquirement of the pilaster permitted, the dimensions of the distal epiphysis not increasing at the same rate.

Just as for the proximal epiphysis the Gibbons hold an anomalous place among the *Simiinae*, if judged by the Distal Breadth Ratio. We have *Dryopithecus rhenanus* 14·5, Recent Gibbon 13·15, and for comparison *Ateles* 15·1, values corresponding to a much earlier stage of femoral development than that of the Greater Anthropoids or of the *Hominidae*. The suggestion again is that of a troglodyte rather than a hylobatic ancestor for Man.

Table XXVII. *Proximal Breadth and Distal Breadth Ratios.*

Group		Proximal Breadth Ratio		Group	Distal Breadth Ratio	
Lemuroidea	*Tarsiidae* (2)	13·4	Mean 15·92	*Tarsiidae*	10·8	Mean 13·45
	Lorisinae (6)	15·2		*Indrisinae*	11·4	
	Indrisinae (8)	15·45		*Lemurinae*	13·4	
	Galaginae (6)	16·4		*Galaginae*	14·4	
	Chiromyrdae (2)	17·25		*Chiromyrdae*	15·0	
	Lemurinae (18)	17·8		*Lorisinae*	15·7	
Cebidae	*Nyctipithecinae* (8)	14·2	Mean 16·16	*Brachyurus*	12·9	Mean 15·57
	Brachyurus (2)	14·55		*Pithecia*	13·2	
	Pithecia (2)	14·85		*Nyctipithecinae*	14·85	
	Ateles (4)	16·0		*Ateles*	15·1	
	Mycetes (2)	16·75		*Hapalinae*	15·3	
	Hapalinae (16)	17·3		*Cebus*	15·9	
	Cebus (6)	17·4		*Mycetes*	17·3	
	Lagothrix (2)	18·25		*Lagothrix*	20·0	
Simiadae	*Cercocebus* (4)	16·15	Mean 17·88	*Cercocebus*	13·25	Mean 15·10
	Semnopithecus (10)	16·2		*Semnopithecus*	14·5	
	Cercopithecus (8)	18·35		*Cynocephalus*	15·6	
	Macacus (14)	19·3		*Cercopithecus*	15·7	
	Cynocephalus (8)	19·4		*Macacus*	16·45	
	Dryopithecus rhenanus (1)	17·6		*Dryopithecus rhenanus*	14·5	
Simiinae	Gibbon (2)	15·0		Gibbon	13·15	
	Chimpanzee (2)	22·15	Mean 25·57	Chimpanzee	22·25	Mean 23·26
	Gorilla ♂ (4)	27·85 } 27·06		Orang-utan	22·9	
	,, ♀ (3)	26·0		Gorilla ♂	24·95 } 24·63	
	Orang-utan (5)	27·5		,, ♀	24·2	
	Pithecanthropus erectus (1)	21·1		*Pithecanthropus erectus*	17·8	
Hominidae Primogenial Man	Neanderthal Type (7)	25·1	Mean 23·04	Neanderthal Type	21·6	Mean 20·08
	Galley Hill (1)	[24·6?]		Galley Hill	[21·6??]	
	Cromagnon Type (5)	21·6		Cromagnon Type	19·0	
	Grimaldi Type (2)	22·9		Grimaldi Type	19·9	
	H. aurignacensis (*Hauseri*) (1)	21·0		*H. aurignacensis* (*Hauseri*)	18·3	
Recent Man	17th century Londoners ♂	22·26 } 22·09		17th century Londoners ♂	18·77 } 18·45	
	,, ,, ♀	21·92		,, ,, ♀	18·13	

In neither Proximal nor Distal Breadth Ratio is *Pithecanthropus erectus* anything but human, and the Trinil femur exhibits no suggestion of Bumüller's *Hylobates giganticus.*

The position of *Lagothrix* in these characters, as in many others, is exceptional and deserves attention. We should like to see a more complete study of the femur—indeed of all the long bones of this monkey.

Concluding Remarks.

(i) The hylobatic group as far as the femur is concerned stands so far apart from the other Anthropoids that the femoralogist alone would scarcely include the Gibbon in this family.

(ii) The fossil *Dryopithecus rhenanus* is closely allied to the Recent Gibbons, and on this ground it might be well to accept Dubois' proposed renaming of *Pliohylobatis eppelsheimensis*. Pohlig's proposed *Paidopithex rhenanus* seems to suggest only Schleiermacher's original blunder[1].

(iii) Our detailed study of the general characters of the femur and of the special characters of its shaft compels us to associate the human femur with those of the Greater Anthropoids, not with that of *Hylobates*, or as we may express it with a troglodytic rather than with a hylobatic origin.

(iv) *Pithecanthropus erectus* is for all the characters we have been able to study human and, what is more important still, recent human, and bears no resemblance to Primogenial Man. In some cases the Trinil femur diverges towards that of the *Recent* Gibbon, but not more than many human femora do. In our opinion these divergences tell rather against than for the hypothesis of *Pithecanthropus* as a missing link between ape and Man. In particular it seems impossible to accept for the femur Schwalbe's *Pithecanthropus*—Neanderthal Man—Recent Man chain. It would involve a more troglodytic form inserted between two "recent human" links. Dubois' arguments that the femur of *Pithecanthropus* is human because he was erect, and that a femur can take a human character without being human[2], seem to us invalid. The femur of Neanderthal Man differs very considerably from that of Recent Man, and probably because he was less erect. We should anticipate that the missing link would in itself be less erect than Neanderthal Man and still less erect than Recent Man, and accordingly the femur would differ still more than that of Neanderthal Man from Recent Man.

If *Pithecanthropus* be an ancestor of Recent Man, all we can say is that the missing links we personally should be excited about would be those that correspond to the branch points in the human ancestry of Neanderthal Man and of the Greater Anthropoids.

(v) We find little if any justification for Bumüller's view that *Pithecanthropus erectus* should be rechristened *Hylobates giganticus*. The nearest approach to such a being is *Dryopithecus rhenanus*, and the Trinil femur just because it resembles that of Recent Man differs widely from that of Eppelsheim.

(vi) We have noticed in a very considerable number of femoral characters a continuous change in one sense from Lemuroids to *Simiadae*, then a big forward step in the same sense to the Greater Anthropoids, and continued still in the same sense from the Greater Anthropoids to Neanderthal Man, with a culmination in Cromagnon Man. After Cromagnon Man the character generally reverses its trend, so that

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[1] Bibl. 68 *ter*.

[2] Bibl. 68 *quarter*, p. 159.

Recent Man returns to a position nearer to the Greater Anthropoids, or in some cases nearer to the *Simiadae* than to Neanderthal Man. This apparent reversion to the pithecoid we have frequently had occasion to refer to. We believe it to be of very great significance, because it involves the principle that, if, as we believe, Neanderthal and Cromagnon Men, or branch points approximating to them, are in the direct descent of Recent Man, then intermediate steps between Neanderthal and Cromagnon forms will resemble in a good many of their characters, *but not in all of them*, Recent Man, and may be easily on the basis of inadequate examination mistaken for Recent Man. The most significant deviations from Recent Man would lie in more massive epiphyses—the shape of the distal articular surface, considerable bowing, and probably less pilaster[1]. The view that the Galley Hill femur is that of Recent Man seems to us erroneous (see Chapter X), but we find such grounds as there are for it in the consideration that it was an intermediate in the Neanderthal to Cromagnon series. In the same manner the resemblance of the *Homo aurignacensis* (*Hauseri*) to Recent Man may, we believe, be accounted for. It is like Recent Man because it lies between Neanderthal and Cromagnon; this is emphasised by the fact that it probably was a woman's femur and accounts for the resemblance that Klaatsch finds between it and the Galley Hill femur.

Unfortunately some of the most important characters of this Aurigniac femur are at present unknown or very doubtful; we have no good photographs nor any cast, and we cannot implicitly trust even the measurements which Klaatsch does provide. However, we may note the following characters, wherein to avoid the question of sex we have considered only angles and indices:

Character	Neanderthal Type	*Homo aurignacensis* (*Hauseri*)	Cromagnon Type	Recent Man
Midtrochlear Angle	9°·6	8°·5	6°·7	7°·8
Collar Angle	115°·0	120°·0	126°·0	130°·0
Lemotic Index	11·1	11·5	11·1	12·0
Bust Shaft Index	20·2	18·8	18·7	20·0
Capital Ratio	12·4	9·6	10·2	10·0
Epiphysial Ratio	83·0	92·0	92·3	96·5
Pilastric Index	108·1	114·0	125·1	103·0
Soffit Index	45·8	45·3	51·5	50·0
Index of Proximal Gracility	82·4	84·7	79·3	89·0
Index of Transverse Slenderness	7·8	6·8	6·4	7·3
Distal Articulation Index	79·4	85·3	88·3	89·0
Rotular Ratio	3·95	4·60	5·42	5·6
Rotular Index	24·0	30·5	32·4	36·7
Diaphysial Rotular Ratio	4·7	5·2	6·3	6·6

It is quite possible to arrange another series of indices—perhaps not quite so impressive as the above—showing that *Homo aurignacensis* (*Hauseri*) lies between Cromagnon and Recent Man. What, then, is our argument? Why, *that where we*

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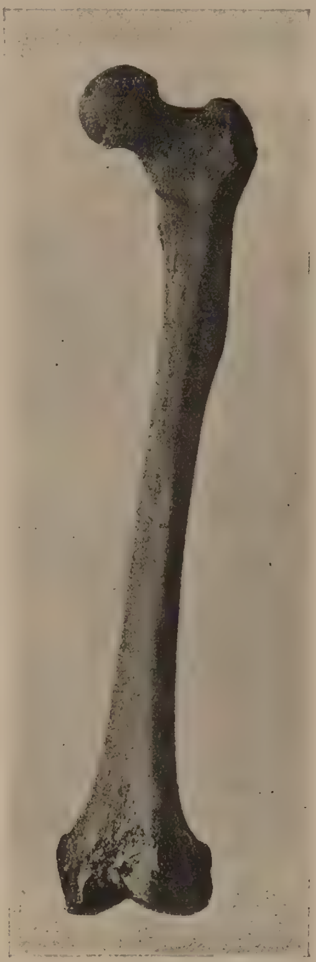
[1] We say *probably* less pilaster, because we have not only to allow for individual variation, but to remember that while Cromagnon Man contributed in broad and exaggerated form the pilaster to the *Hominidae* it was probably started before the appearance of that type and has diminished since.

have only a single individual to judge from, the determination of its associations, even when exact and complete measurements exist, is not a straightforward task, and a brief inspectional assertion that Galley Hill or Hauser's Aurigniac Man are "recent," is worth very little indeed from the standpoint of exact science. All we venture to propound is that both Galley Hill (see Chapter X) and Hauser's Aurigniac Man may well be Neanderthal-Cromagnon intermediates for all the evidence yet presented, and if they should be, then we fear that Klaatsch's double origin of Man, orangoid[1] and gorilloid, falls with the "recent man" attribution of these two femora.

"Frontal Pilaster"



Femur of a Fuegian, reproduced by permission of Prof. Rudolf Martin (*Lehrbuch der Anthropologie*, Fig. 435). This femur combines two primitive anomalies, *i.e.* the lateral protrusion of anterior face and the "frontal pilaster" characteristic of the Lemuroids. Prof. Martin uses this femur to illustrate the combination of marked platymery and sensible pilaster.

(vii) If we endeavour to sum up the associations we have found between Man and the Greater Anthropoids on the basis of our study of the primate femur, we believe it can be best done by a comparison of what appears to us in the roundest and roughest of numbers to have been the general characters of the femur and the special characters of the shaft in the case of the supposed protsimio-human, the branch point of Man and the Greater Anthropoids. We may preface our table of values by saying that we should anticipate no more pilaster than is found in some of the *Simiadae*; there will be very frequently, if it be not indeed a specific character, a *fossa hypotrochanterica*; *slight* lateral protrusion of the anterior face and *slight* ridge form of third trochanter will either be specific or occur more frequently as anomalies than in Recent Man; there might be anticipated to be a broad if short crural trough, bounded occasionally as an anomaly by a "frontal pilaster"—see the accompanying figure and Plate LXV; there will be a poorly marked popliteal apex, and the popliteal surface will be convex, but probably not so markedly convex as in the case of the Greater Anthropoids or Neanderthal Man; the patellar surface will be more symmetrical, and the upward projection of it on the lateral side of the anterior face will have wholly or partially disappeared; the head will be well defined, but considerably cut away at the top of the neck to mesial border; also the

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[1] Judging by the characters of the femur, "orangoid" is hardly the correct word, we believe the better opposites would be hylobatic and troglodytic. The latter word weakens down the second or "gorilloid" terminology. Not only is the femur of Neanderthal Man distinctly not gorilloid except to the most superficial examination, but the gorilla is "recent" and lies nowhere close to the supposed troglodytic ancestor of Man, who in many respects would be more human than even chimpanzee-like.

TABLE XXVIII. *General Characters and Characters of the Shaft for the Hypothetical Protsimio-human.*

	Character	Recent Gibbon	Hypothetical Protsimio-human	Recent Chimpanzee	Recent Man ♂ + ♀
Major Lengths	Maximum Length	193·6	325	314·6	428·22
	Trochanteric Length	192·2	318	311·0	407·45
	Max. Troch. Length	193·1	329	313·4	416·18
	Oblique Length	193·5	322·5	311·6	425·37
	Troch. Obl. Length	192·2	318	311·8	404·60
	Capito-trochlear Length	187·4	301	303·7	413·14
	Diaphysial Length	170·7	273	261·8	363·28
	Length of Shaft	174·9	271·5	257·4	362·42
Shaft	Proximal Breadth	28·8	70·0	68·5	90·10
	Platymeric A.-P. Diameter	9·0	22·7	22·0	25·16
	Platymeric Trans. Diameter	10·8	25·8	26·2	30·12
	Pilastric A.-P. Diameter	9·5	22·8	21·4	27·36
	Pilastric Trans. Diameter	8·8	23·25	25·9	26·63
	Popliteal Width	11·1	31·0	34·4	37·78
	Popliteal Direct A.-P. Diameter ...	8·7	21·7	23·5	26·15
	Popliteal Oblique A.-P. Diameter ...	8·6	22·4	25·2	28·76
Angles	Mid-trochlear Angle	7°·3	8°·5	9°·0	7°·79
	Angle at Centre of Head	58°·3	51°·0	37°·8	42°·14
	Collar Angle	114°·5	120°·5	133°·3	130°·39
	Torsion of Shaft	5°·3	15°·0	10°·5	24°·90
	Torsional Angle	16°·0	6°·0	3°·8	14°·77
	Retorsional Angle	−10°·7	9°·0	6°·7	10°·26
	Obliquity of Shaft	3°·0	3°·0	−0°·1	10°·40
General Indices	Obl. Direct Lengths Index	100·0	99·2	99·1	99·30
	Obl. Direct Troch. Lengths Index ...	100·0	100·0	100·3	99·42
	Proximal Breadth Ratio	15·0	22·0	22·2	22·06
	Distal Breadth Ratio	13·2	19·5	22·3	18·45
	Pithecoid Index	99·3	98·6	100·0	95·25
	Robusticity of Femur	9·4	14·3	15·2	12·70
Indices of the Shaft	Platymeric Index	83·7	88·0	83·8	84·04
	Pilastric Index	108·2	98·0	82·8	103·02
	Popliteal Index	78·2	70·0	68·3	69·38
	Index of Popliteal Skewness	100·6	96·9	93·4	90·76
	Soffit Index	43·9	50·0	49·6	50·42
	Index of Proximal Gracility	81·4	90·0	98·7	88·72
	Index of Distal Gracility	79·0	75·0	75·3	70·87
	Index of Transverse Slenderness ...	5·0	8·6	10·0	7·35
	Index of Sagittal Slenderness	5·4	8·4	8·3	7·36
	Index of Proximal Taper	95·2	99·6	102·4	92·02
	Index of Distal Taper	91·5	95·2	109·6	95·97
	Primary Index of Bowing	−0·2	3·2	2·95	2·53
	Secondary Index of Bowing	70·95	49·0	43·0	38·99
	Bicondylar Width	25·3	62·0	69·3	74·88

head will be slightly above the great trochanter; the patellar surface will be short to medium height, very slightly elevated above the anterior face and without trace of tongue, except as an anomaly.

Difference in absolute size varies very much with the individual; it may run to 100 mm. in the genera of one primate family, and approaches 100 mm. even in the one species of Recent Man; it is accordingly very difficult to fix on a mean value for our protsimio-human. This is emphasised by the fact that the tendency of recent evolution has been rather towards a decrease in size—evidence of which may be seen in the Gibbon since Pliocene and in Man since Cromagnon times. For mere fixing of ideas we may credit our protsimio-human with a maximum femoral length of 300 to 350 mm. or, say, 325 mm. The stature, if this being had been erect, would have been something less than those of Bushmen or Andamans, and approached nearer to that of the Akkas, say, 120 to 125 cms.

The *absolute* measurements of course depend upon this choice of maximum length and would be modified if this were changed. What we have endeavoured to select are rough values of the general indices and those of the shaft. These were reached by a very careful consideration of what the values were likely to be of the branch points of the *Simiadae* and of the Greater Anthropoids on the main line of human descent. In judging we have supposed that line to pass through the Neanderthal Type, as we hold that the requisite robusticity of the human femur was attained before the pilaster. Accordingly our problem was to carry backward the human line of ascent towards the above branch points. Compromise had of course to be frequently made, but it would require too much space to show the individual reasons for each index value, and after all the matter is of relatively small importance. Till the requisite fossil femur is found our reconstruction remains at best but an *espièglerie*, and when the protsimio-human missing link is found—as found we have no doubt it will be—then all guesswork will be replaced by knowledge, and it will matter little what has been the goodness or badness of previous hypotheses. Science consists not in absolute knowledge, but in the statement of the probable on the basis of our present—invariably limited—acquaintance with facts.

But our table—as those at the ends of the following chapters will do—does sum up the authors' present acquaintance with facts and indicate why a troglodytic rather than a hylobatic ancestry is to be preferred for Man. It will be seen that the indices are as a rule intermediate between those of Recent Gibbon and Recent Chimpanzee, but almost invariably nearer to those of the latter. If Recent Man was evolved from a hylobatic ancestry, even of the *Pliohylobates* type, and not from a line which had acquired the robusticity of the Greater *Simiadae* and of the Greater Anthropoids, it is surprising that he should have acquired such a complex of troglodyte characters as his femur presents. But had he developed on parallel lines, he would hardly have acquired these characters as anomalies, and even then he must have passed through something like a Neanderthal stage to obtain his present robusticity and present proportions of epiphyses and diaphysis. These are undoubtedly troglodytic and not hylobatic.

CHAPTER VIII

CHARACTERS OF THE PROXIMAL EPIPHYSIS

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(i) Proximal Breadth.

We have already stated our objections to the proximal breadth when discussing (p. 233) Klaatsch's Proximal Breadth Index. It does not seem to us a satisfactory measure of the absolute size of the proximal epiphysis. It covers the area of two centres of ossification, and it is by no means easy to obtain a convention for its measurement which will insure the absence of marked personal equation. We have endeavoured to measure it from that point of the articular surface of the head which is furthest removed from the standard sagittal plane to that point of the surface of the great trochanter which is also furthest removed from the same plane, taking the maximum value of this length and not the projection of that maximum value on the standard horizontal plane. Possible variations of the proximal breadth are (i) the above projected value, (ii) the value obtained by placing the sliding bars of the calipers parallel to the shaft, (iii) the distance from the articular surface centre of the head to the point where the capito-collar axis if produced beyond the coaxial point cuts the surface of the great trochanter; and others can easily be imagined. All present considerable difficulty in practice. Before we proceed to discuss the absolute and relative size of the femoral head, we have thought it worth while to consider briefly the data we possess for the proximal breadth and ascertain what may be learnt from them with regard to the primates as a whole.

The table below scarcely needs summarising; we see that the proximal breadth of the primate femur has risen steadily from *Tarsius* and the *Galaginae* to Cromagnon Man, and then has fallen in Recent Man to more apelike dimensions. The modern Gibbon again appears as a possible degenerate (as far as size is concerned) from a larger fossil ancestor, more in keeping with other *Simiinae*. *Pithecanthropus erectus* is purely Recent Man-like. The reconstructed Grimaldi Type adult male appears as a transition form between Cromagnon and Recent Man. Galley Hill is closer to the Neanderthal Type than to Recent Man; it is far removed from the relation to *Homo aurignacensis* (*Hauseri*), which Klaatsch overhastily assumed[1]. Modern Europeans and Negroes are nearer to the Neanderthal Type than any of the few primitive races for which we have material, while, according to Prochownick, the Australian femur for proximal breadth is anything but Neanderthaloid.

TABLE XXIX. *Proximal Breadth of Femur**.

	Group	Proximal Breadth		
Lemuroids	*Tarsiidae* (2)	8·55	Mean 10·07	Mean 16·42
	Galaginae (6)... ...	10·0		
	Lorisinae (6)	11·65		
	Chiromyrdae (2) ...	21·35	Mean 22·77	
	Indrisinae (8) ...	23·45		
	Lemurinae (18) ...	23·5		
Cebidae	*Hapalinae* (16) ...	11·4	Mean 20·85	
	Nyctipithecinae (8) ...	12·7		
	Pithecia (2)	18·9		
	Lagothrix (2)	20·1		
	Cebus (6)	20·7		
	Brachyurus (2) ...	22·4		
	Mycetes (2)	24·9		
	Ateles (4)	35·7		
Simiadae	*Cercopithecus* (8) ...	26·4	Mean 35·03	
	Semnopithecus (10) ...	33·2		
	Macacus (14)... ...	33·85		
	Cercocebus (4) ...	36·0		
	Cynocephalus (8) ...	45·7		
	Dryopithecus rhenanus	50·0		

	Group		Proximal Breadth		
Simiinae	Gibbon (2)		28·75		
	Orang-utan (5)		60·3		Mean 73·94
	Chimpanzee (2)		68·5		
	Gorilla (4)		♂ 103·3	93·01	
	„ (3)		♀ 79·3		
	Pithecanthropus erectus (1) ...		92·0		
Primogenial Man	Neanderthal Type (7) ...		102·0		
	Galley Hill (1)		100·1		
	Cromagnon (5)		110		
	Grimaldi Type (2)		[107]		
	Homo aurignacensis (*Haus.*) (1)		86		
Recent Man	17th century Londoners	(73)	♂ 94·54	Mean ♂ 86·04, ♀ 80·15	
		(62)	♀ 85·32		
	Negroes (Various) ...		♂ [92·8]		
			♀ [85·3]		
	Fuegians †	(5)	♂ 80·20		
		(4)	♀ 84·25		
	Viti Islanders ‡ ...	(24)	♂ 84·42		
		(7)	♀ 78·86		
	Caroline Islanders ‡ . .	(8)	♂ 82·50		
		(4)	♀ 75·20		
	Australians ‡	(5)	♂ 81·80		
		(3)	♀ 72·00		

* We have omitted from this table the measurements of Klaatsch on a few *selected* individuals of special races, as we consider that they have too little weight to be of value in interracial problems. We have introduced them in the table on p. 233, chiefly as a basis for the criticism of them provided in the fifth footnote p. 232.

† Hultkrantz, Bibl. 85.

‡ Prochownick, Bibl. 43. We find for our four Australian femora—2 ♂ 104·8, 2 ♀ 87·25—values far in excess of Prochownick's.

It might be convenient to make a division across the Lemuroids in the manner we have indicated in the table, in which case the subtypes would be *Galaginae* and

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[1] Bibl. 103^{bis}.

Indrisinae; otherwise the *Lorisinae* form the type, but not very closely. In the *Cebidae Cebus* is again type, and *Cercocebus* for the *Simiadae*. The Chimpanzee is nearest to type of the Greater Anthropoids. It is practically the type for the *Simiinae*, if *Dryopithecus* but not the Recent Gibbon be included. The inclusion of the latter transfers the type for this size character to the Orang. If it is safe to strike a mean on our six races of Recent Man we have ♂ 86·04, ♀ 80·15. The nearest race of our small series to type would then be the Fuegian, which for several more valid reasons we are disposed to consider as approaching Protoneoteric Man.

Of course any conclusions from the data for Recent Man as far as these are due to Hultkrantz and Prochownick depend upon those authors having taken the ill-defined proximal breadth approximately in our manner.

(ii) Absolute and Relative Size of the Femoral Head.

We now turn to the characters of the bust. In the first place the dimensions of the head must occupy our attention. They have peculiar interest whether treated absolutely or relatively, for they form one of the few generally admitted links between the apes and Primogenial Man of the Neanderthal Type. We may deal either with the vertical diameter[1] of the head as measuring as a rule its maximum dimension, or with the indices formed by the ratio of this diameter (i) to the length of the femur, (ii) to the bicondylar width[2], or (iii) to the length of the capito-collar axis. In the following table we classify according to absolute values and further according to the first two of these indices.

Now this table is remarkably suggestive and confirms the views to which we have already given expression—there is no close link between Primogenial Man and Primitive Modern Man. The European, ancient and modern, is closer in absolute size of femoral head to Primogenial Man than the Maori, the Negro, the Australian or the Andaman. If we turn from absolute size to the Capital Ratio—the proportion of head to size of femur—the apes are seen to be close in this proportion to Primogenial Man; the European separates both these groups from the primitive and uncivilised

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[1] Although we do not put much faith for interracial purposes in the ellipticity of the head, we yet think it best to measure *both* vertical and horizontal diameters, and object to the vague taking of the "maximum diameter wherever found." The Secondary Neck Index, *i.e.* the ratio of minimum horizontal diameter of neck to horizontal diameter of head, is of interest, and the horizontal diameter of the head might be profitably compared with the length of the internal condyle. The vertical diameter of the head seems properly chosen for the capital index, and generally it is easier to determine than a non-orientated "maximum diameter."

[2] For femoral characters there is very considerable correlation between the vertical diameter of the head and the bicondylar width. For our London femora we have found (p. 194)

♂ R. ·750 ± ·024 (146); ♂ L. ·770 ± ·023 (146); ♀ R. ·584 ± ·048 (87); ♀ L. ·654 ± ·038 (104)

while Tamagnini and De Campos (Bibl. 118, p. 32) give for Portuguese femora in the case of the diameter of the head and the breadth of the distal articulation

♂ (R. + L.) ·63 ± ·03 (264); ♀ (R. + L.) ·63 ± ·03 (250),

confirming the high value, but not indicating our sexual difference. This is possibly due to their measuring the articulation only.

TABLE XXX. *Table of the Vertical Diameter of the Head and of the two Capital Indices.*

	Race	Vertical Diameter of the head			Capital Ratio $=100\,\frac{\text{Vert. Diameter}}{\text{Max. Length}}$			Capito-Bicondylar Ratio $=100\,\frac{\text{Vert. Diameter}}{\text{Bicondylar Width}}$		
Lemuroidea	*Tarsiidae*	3·7 (2)		Mean 7·88	5·75 (2)		Mean 7·74	53·6 (2)		Mean 57·38
	Galaginae	4·7 (6)			7·8 (6)			54·35 (6)		
	Lorisinae	7·2 (6)			9·2 (6)			59·5 (6)		
	Chiromyrdae	10·3 (2)			8·3 (2)			55·35 (2)		
	Indrisinae	10·6 (8)			7·1 (8)			61·0 (8)		
	Lemurinae	10·8 (18)			8·3 (18)			60·5 (18)		
Cebidae	*Hapalinae*	5·6 (16)		Mean 10·91	8·5 (16)		Mean 8·38	55·4 (16)		Mean 54·76
	Nyctipithecinae	6·9 (8)			7·8 (8)			53·2 (8)		
	Pithecia	9·3 (2)			7·2 (2)			55·35 (2)		
	Cebus	10·4 (6)			8·7 (6)			55·0 (6)		
	Lagothrix	11·25 (2)			10·05 (2)			51·15 (2)		
	Brachyurus	11·65 (2)			7·55 (2)			58·55 (2)		
	Mycetes	13·5 (2)			8·9 (2)			52·55 (2)		
	Ateles	18·7 (4)			8·35 (4)			56·9 (4)		
Simiadae	*Cercopithecus*	12·7 (8)		Mean 16·84	9·0 (8)		Mean 8·80	57·1 (8)		Mean 57·57
	Macacus	16·4 (14)			9·5 (14)			56·8 (14)		
	Cercocebus	16·9 (4)			7·7 (4)			57·25 (4)		
	Semnopithecus	17·0 (10)			8·5 (10)			58·6 (10)		
	Cynocephalus	21·2 (8)			9·3 (8)			58·1 (8)		
	Dryopithecus rhenanus	24·0 (1)			8·4 (1)			58·4 (1)		
Simiinae	Gorilla	47·9 (7)		Mean 37·50	13·5 (7)		Mean 12·67	53·9 (7)		Mean 55·70
	Chimpanzee	34·6 (3)			11·8 (3)			53·1 (3)		
	Orang-utan	30·0 (5)			12·7 (5)			60·1 (5)		
	Gibbon	17·6 (3)			8·6 (3)			58·7 (3)		
	Pithecanthropus erectus	45·0 (1)			9·89 (1)			57·7 (1)		
Primogenial Man	Spy	55·8 (1)		Mean Neanderthal (6) 52·3*	13·0 (1)		Mean Neanderthal (6) 12·4*	59·6 (1)		Mean Neanderthal (6) 59·7*
	,, [Klaatsch	53·0 (2)			12·8 (2)			58·9 (2)]		
	Neanderthal	54·0 (1)			12·1 (1)			60·3 (1)		
	,, [Klaatsch	53·0 (2)			11·9 (2)			60·3 (2)]		
	La Chapelle-aux-Saints	51·6 (1)			12·0 (1)			61·4? (1)		
	Galley Hill	49·2 (1)			11·6 (1)			55·9?? (1)		
	Homo mousteriensis (*Hauseri*)	47·7 (1)			12·4 (1)			57·3 (1)		
	Homo aurignacensis (*Hauseri*)	41·0 (1)			9·6 (1)			54·7 (1)		
	Cromagnon	54·6 (5)			10·2 (5)†			57·6 (5)		
	Grimaldi Type	52·0 (2)			10·3 (2)			56·0 (2)		
		♂	♀		♂	♀		♂	♀	
Recent Man	Bajuvars from Row Graves	50·1 (18)	44·0 (8)		10·6 (18)	10·3 (8)		61·9 (10)	62·2 (1!)	
	Rothwell, English	49·14 (174)	42·46 (105)		10·7 (174)	10·2 (101)		{64·3 (160)}	{62·9 (88)}	
	Ancient Persians (Anau)	49·0 (2)	—		10·3 (2)	—		56·0 (2)	—	
	Swabians and Alemanns from Row Graves	48·3 (10)	41·5 (4)		10·3 (10)	10·4 (4)		60·3 (6)	58·4 (2)	
	Romano-British	47·9 (7)	—		10·5 (6)	—		59·7 (3)	—	
	Modern British	47·6 (39)	—		10·3 (39)	—		58·8 (39)	—	
	Modern Swiss	47·1 (22)			10·4 (20)			58·2 (22)		
	Modern French	47·0 (62)	41·0 (38)		10·6 (60)	10·2 (40)		—	—	
	Hindoos	47·0 (6)	36·5 (2)		9·8 (6)	9·1 (2)		58·3 (6)	54·9 (2)	
	17th century Londoners...	46·91 (416)	40·94 (319)		10·49 (390)	10·03 (296)		59·02 (289)	58·22 (194)	
	Neolithic Man (Châlons-sur-Marne) ...	46·5 (23)	40·8 (10)		10·5 (23)	9·95 (10)		—	—	
	North American Europeans	46·5 (200)	41·3 (200)		[10·4 ?]	[9·9 ?]		—	—	
	Portuguese	46·33 (264)	40·19 (250)		10·3 (134)	9·9 (126)		{61·7 (264)}	{61·5 (250)}	
	Fuegians	46·3 (10)			10·8 (10)			57·2 (10)		
	Neolithic Man (Montigny Esbly) ...	45·0 (10)	40·0 (4)		10·2 (10)	9·9 (4)		—	—	
	Maori	44·9 (10)	41·4 (7)		10·1 (10)	10·1 (7)		56·2 (7)	61·0 (7)	
	Negroes	44·9 (10)	40·0 (3)		9·7 (10)	9·2 (3)		57·1 (10)	55·7 (3)	
	Australians‡	44·1 (12)	33·5 (2)		9·4 (12)	8·2 (2)		56·9 (12)	55·2 (2)	
	Neolithic Man (Chamblands)	44·0 (20)	40·5 (18)		10·5 (20)	10·2 (18)		—	—	
	Neolithic Swiss Dwarfs	—	38·0 (3)		—	10·1 (3)		—	56·1 (3)	
	Andamans	36·6 (8)	35·1 (4)		9·6 (8)	9·7 (4)		54·4 (8)	57·0 (3)	

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* In the Tables throughout this Chapter the mean Neanderthaloid values are taken from Table III in Chapter X and are *not* the mean of the four Neanderthaloid femora provided in the first columns. They include in each case what measurements were available on casts and photographs of Spy, Neanderthal, *H. mousteriensis* (*Hauseri*), *La Chapelle-aux-Saints* and *La Ferrassie*.

† Based on mean vertical diameter for 5 femora given by Verneau (Bibl. No. 94 *quater*, Tom II, Fasc. 1, p. 108), and on the maximum length as deduced from the oblique length of 13 femora given by Rodriguez we find 10·1 instead of 10·2. See Table III in Chapter X.

‡ We find for our own *four* Australian femora:

Vertical Diameter of Head ♂ 49·05, ♀ 42·35; Capital Ratio ♂ 10·85, ♀ 10·6; Capito-Bicondylar Ratio ♂ 61·4, ♀ 60·0; results wholly out of keeping with those of Hepburn in the above table.

man. In the case of the ratio of head to bi-epicondylar width the European is closest to Primogenial Man[1], and separates the latter from Primitive Man, and the still more emphasised distal epiphysis of the apes. In fact a consideration of the head in no case suggests as an evolutionary order: Apes, Primogenial Man, Primitive Modern Man, Modern Civilised Man. This table gives no encouragement to the view that the Australian as far as his femur is concerned is in any way akin to Primogenial Man. The Trinil femur as far as its head is concerned is widely differentiated from those of the apes and Primogenial Man; it might in this respect well be the femur of a Melanesian or a Negro.

Turning now to the Primates as a whole we note a steady increase in absolute size of head from Lemuroids to Man although the progress was much accelerated in the *Simiadae* as compared with the *Cebidae*. With Man the progress in size continued through Neanderthal to Cromagnon Type, but after that declined considerably for reasons which are at present unrecognised. Some light, however, may be thrown on the matter if we pass from absolute to relative size, which is always more satisfactory. Here in the Capital Ratio we see that while *Cebidae* and *Simiadae* increased somewhat on relative size of head on the Lemuroids, the main advance was made with the Greater Anthropoids and Primogenial Man of the Neanderthal Type—the Gibbon, fossil and recent, having much the same relative size of head as *Ateles* in the *Cebidae* and *Semnopithecus* in the *Simiadae*, *i.e.* it had not advanced in this respect beyond the Lesser Ape mean values. The change to the Recent Man value came with Cromagnon Man. Thus Cromagnon was not on the summit as for absolute size of head, but already on the decline towards Lesser Ape values. It is another case of "scission of the Primates" in which modern man stands between the Lesser Apes and the Greater Anthropoids.

If we turn to the Capito-bicondylar Ratio, we find on the whole very little variation throughout the Primates; the mean value for the Lemuroids can easily be paralleled from existing races of man. The bicondylar width increases relatively to the head from Lemuroids to *Cebidae*, and less markedly but uniformly from Lemuroids through *Simiadae* to the Anthropoids. But with Primogenial Man we note a rise of a marked kind, and Recent Man follows with a slight fall which places him in this respect on the same level as fossil and recent Gibbons. On the whole this index is wonderfully persistent in the Primates and there is no racial human value which does not fall within the range of values exhibited by the Lemuroid genera. It will be seen that the determination of type forms in the various families for these three characters is by no means clear. On the whole the *Lorisinae* seem to be nearest to type in the Lemuroids, *Cebus* in *Cebidae*, and *Cercocebus* in the *Simiadae*. In the case of the Greater Anthropoids, honours for both 1st and 2nd places are shared equally, but the total deviation from type of the Chimpanzee is only 4·37 points, while those of the Orang and Gorilla are 12·20 and 13·03 respectively. Hence the Chimpanzee may be considered nearest to type.

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[1] We must dismiss the Rothwell English and Portuguese from this comparison for in both cases the articulation and not the bi-epicondylar breadth has been measured.

Closely allied to the Capital Ratio is the so-called Robusticity of the Head which is given by 100 × sum of the head diameters/maximum length. For practical purposes this is twice or still more accurately $\left(1+\frac{E}{100}\right)$ times the Capital Ratio, where E is the ellipticity of the head. Some writers use the circumference of the head in place of the sum of the two diameters. This measure of the robusticity is very nearly π times the former measure and 2π times the Capital Index. Rodriguez has given very complete returns for both the robusticity of the head and for the ellipticity. Unfortunately he combines male and female, and uses the oblique instead of the maximum length. Hence for comparison with our data we should have to combine our sexes after reducing our indices to oblique length. It seemed better accordingly not to mix the sexes but to give Rodriguez's data for these characters in a separate table, which will stand a fair comparison with the table just given. These results as well as those on p. 361 for the Capito-collar length are based on the assumption that the following indices: Robusticity of Head ($I_{(f+g)/d}$), Ellipticity of Head ($I_{g/f}$) and the Capito-collar Index or Secondary Bust Ratio ($I_{t/d}$), are approximately the same for the two sexes, and that the differentiated absolute lengths of the two sexes may be found from them by using the Oblique Length (d) for the femur which Rodriguez does give for both sexes. In the case of the Capital Ratio the reconstructed Vertical Diameter of the Head (f) was divided by the Maximum Length (a) reconstructed from the Oblique Length (d) by means of the results given on our p. 226.

The formulae involved are the following:

$$\text{Vertical Diameter of Head } (f) = \frac{I_{(f+g)/d}}{100 + I_{g/f}}\, d,$$

$$\text{Capito-Collar Length } (t) = \frac{I_{t/d}}{100}\, d,$$

$$\text{Capital Ratio} = 100\, f/a,$$

$$\text{Head-Bust Ratio}^1 = \frac{100}{1 + I_{g/f}/100}\, \frac{I_{(f+g)/d}}{I_{t/d}}.$$

In the case of the Capital Ratio the very slight differences between the values for the two sexes arise solely from the different corrections to be made when the Oblique Length (d) is transformed to the Maximum Length (a). In deducing results from this table the reader must be cautioned to regard the smallness of a considerable number of the series. Further, especially in the case of ancient bones, the larger are more likely to survive, and many osteometrical investigators appear to neglect the collection or the measurement of fragments, which usually belong to the less robust femora. We have little doubt that this is one of the factors which have contributed to Parsons' English femoral head rivalling in absolute size that of the Patagonians.

For classificatory purposes we propose to introduce the following terms as convenient:

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[1] Used to provide values from Rodriguez's data for the Head-Bust Ratio column in Table XXXII of p. 354.

TABLE XXXI. *Vertical Diameter of Head and Capital Ratio of the Femur of Various Races deduced from Rodriguez's Data.*

Race	No. ♂ + ♀	Vertical Diameter ♂	Vertical Diameter ♀	Race	No. ♂ + ♀	Capital Ratio ♂	Capital Ratio ♀
Spy	1	54·5	—	Spy	1	12·7	—
Cromagnon	13	54·4	—	Cromagnon	13	10·9	—
Gauls and Romano-Gauls	78	49·3	44·5	Laplanders	6	11·1	—
Patagonians	101	49·2	44·1	Japanese	92	11·0	11·0
Franks and Burgundians	30	48·8	44·9	Turks	18	10·9	—
Modern Germans	18	48·6	?	Chinese	6	10 9	10·9
Mediterranean Race	32	48·3	44·2	Eskimo	13	10·7	10·7
Negritos	42	47·6	36·4	Gauls and Romano-Gauls	78	10·7	10·6
Fossil Grimaldi Negroes*	3	—	43·5	Ancient Slavs	43	10·7	10 7
Mediaeval French	183	47·5	43·8	Peruvians	75	10·7	10·7
Modern French	69	47·4	45·7	Ancient Bolivians	51	10·6	10·5
Ancient Slavs	43	47·3	43·9	Patagonians	101	10·6	10·6
Turks	18	47·1	—	Fuegians	12	10·6	10·5
Merovingians	40	46·4	42·8	Franks and Burgundians	30	10·6	10·5
Neolithic Europeans	240	46·0	42·1	Mediterranean Race	32	10·6	10·6
Fuegians	12	45·8	42·6	Ancient Mexicans	22	10·5	10·5
Eskimo	13	45·7	44·0	Mediaeval French	183	10·5	10·5
Phoenicians and Carthaginians	16	45·5	41·8	Modern French	69	10·5	10·4
				Modern Germans	18	10·5	10·5
Polynesians	18	45·5	42·4	Ancient Equatorial Indians	126	10·5	10·4
Berbers and Guanches	94	45·5	42·7	Europeans, Bronze Age	46	10·4	10·4
Negroes of Guinea	16	45·5	—	Basques	35	10·4	—
Japanese	92	45·5	41·7	Phoenicians and Carthaginians	16	10·4	10 3
Chinese	6	45·3	44·1				
Europeans, Bronze Age	46	45·3	39·9	Merovingians	—	10·4	—
Aino	8	45·2	40·6	Aino	8	10·4	10·3
Laplanders	6	44·7	—	Indo-Chinese	16	10·3	10·2
Negroes (? *locus*)	48	44·5	41·1	Indonesians	14	10·3	10·3
Basques	35	44·5	—	Ancient Venezuelians	43	10·3	10·3
Canary Islanders	287	44·3	40·5	Neolithic Europeans	240	10·3	10·3
Ancient Mexicans	22	44·3	41·1	Californian Indians	122	10·2	10·2
Indonesians	14	44·3	42·4	Malays	118	10·1	10·1
Mozambique	13	44·3	41·3	Polynesians	18	10·1	10·1
Peruvians	75	44·1	41·5	Berbers and Guanches	94	10·1	10·1
Ancient Venezuelians	43	44·1	41·0	Ancient Egyptians	22	10·0	10·0
Ancient Egyptians	22	44·0	42·5	Negroes of Guinea	16	10·0	—
Melanesians	80	43·7	40·5	Fossil Grimaldi Negroes*	3	—	10·0
Indo-Chinese	16	43·5	42·2	Negritos	42	9·9	9·8
Ancient Bolivians	51	43·5	39·5	Negroes (? *locus*)	48	9·9	9·8
Californian Indians	122	43·2	40·1	Mozambique	13	9·8	9·8
Veddahs	2	43·0	—	Canary Islanders	287	9·9	9 8
Malays	118	42·9	39·1	Melanesians	80	9·8	9·7
Ancient Equatorial Indians	126	42·9	39·1	Veddahs	2	9·7	—
Congolese	20	42·8	38·6	Hindoos	18	9·7	9·7
Hindoos	18	40·7	40·1	Congolese	20	9·5	9·5

* As to the Grimaldi type see our Chapter X. We do not know where these *three* apparently all *female* femora are deposited.

First with regard to the absolute size of head:

Femora with Vertical Diameters of Head.

Over 50 mm. are *hyperdolichocratic,*
Between 47·0 and 50 mm. are *dolichocratic,*
Between 45·0 and 47·0 mm. are *mesocratic,*
Between 43·0 and 45·0 mm. are *brachycratic,*
Below 43·0 mm. are *hypobrachycratic.*

Primogenial Man falls into the first class; transition to the dolichocratic may be found in the Galley Hill femur, to which group belong prehistoric, early historic and most modern Europeans. Transition to the mesocratic group may be found in our 17th century Londoners; in this group are found also the Eskimo, Fuegians, Guanches and chief Asiatics as well. American Indians and most of the Negroes tend to be brachycratic, passing, however, into both mesocratic and hypobrachycratic classes. Malays, Veddahs and according to the longer series Hindoos are hypobrachycratic. It is noteworthy that the Negritos (possibly also the Grimaldi negroid femora, if really female) are differentiated from the Negroes of Africa and are dolichocratic. In the same group also are to be found the Patagonians widely separated from the rest of the South Americans. The Australians verge on and the Andamans show marked hypobrachycracy, to which class belong all the anthropoids (except the gorilla) and the lesser apes.

Secondly with regard to the size of the femoral head relative to the maximum length:

Femora with Capital Ratio.

Over 11·5 mm. are *hyperdolichocephalic,*
Between 10·5 and 11·5 mm. are *dolichocephalic,*
Between 10·0 and 10·5 mm. are *mesocephalic,*
Between 9·5 and 10 mm. are *brachycephalic,*
Below 9·5 mm. are *hypobrachycephalic.*

Again we see Primogenial Man of the Neanderthal Type in the highest class. He had not only an absolutely large femoral head, but he had a short femoral length. Galley Hill Man suggests again a transitional form. Cromagnon is merely dolichocephalic; although high up in the class, it is surpassed by Laplanders and Japanese and equalled by the Chinese. In fact the big head of the Cromagnon Type was accompanied by an all round big femur. Patagonians, Fuegians, Eskimo, some of the South American Indians and Parsons' Rothwell English (doubtful?) are also dolichocephalic as to femur. At the bottom of the class and passing into the mesocephalic are most modern European races, and many of their historic and pre-historic forerunners. Aino, Indo-Chinese, Malays, and Polynesians and Maori are found towards the bottom of the mesocephalic group, where the Negroes, Negritos and Grimaldi negroid fossil bones form a transition group to the brachycephalic category which contains Veddahs, Andamans, and Hindoos also. The only truly hypobrachycephalic race being found in the Australians, who herein approach lesser apes and Lemuroids, which belong to this group.

It will be seen that in the analysis of the femoral head made on the basis of these characters there is no resemblance of the Australian femur to that of Primogenial Man nor indeed of the latter to any primitive type of modern man. The European stands, if at much distance from the former, between the two. Absolutely the same point is brought out if we consider the Capito-bicondylar Index; here there is very little difference between Neanderthal Man and the modern European, but both stand markedly apart from Negro, Fuegian, Maori, Australian and Andaman, in whose femora the distal epiphysis is large as compared to the size of the femoral head.

(iii) HEAD-BUST RATIO.

We may take as our last relative measure of the femoral head its relation to the size of the bust as a whole, *i.e.* the Head-Bust Ratio which is defined as 100 Vertical Diameter of Head divided by the Bust or Capito-collar Axis.

Here again the accompanying table shows marked evidence of the want of an evolutionary serial order for Man. Primogenial Man of the Neanderthal Type, with whose femur is associated in this as in several other features the Galley Hill femur, heads the list. In Primogenial Man of the Neanderthal Type the diameter of the head is something like 72 $^{\circ}/_{\circ}$ of the bust length. In modern European man it is only 61 $^{\circ}/_{\circ}$. The Cromagnon Type is intermediate, about 64 $^{\circ}/_{\circ}$, which is a value much that of modern Asiatics. Mediaeval and prehistoric Europeans lie between the Cromagnon and modern values. At the bottom of the series lie various "fringe" races, Laplanders, Basques and Veddahs; still lower below the human series lie the apes, although the Gibbon and Orang cross the lowest values of the human series. Again we cannot emphasise any obvious evolutionary order—Modern Man separates the apes from Primogenial Man and forms indeed by his range of values an almost continuous series from the one to the other.

Now if we examine the table from the standpoint of broad primate groups we have for the means:

Lemuroidea,	mean of 6 genera ...	76·73
Cebidae,	mean of 8 genera ...	66·81
Simiadae,	mean of 5 genera ...	70·04
Simiinae,	mean of 4 genera ...	59·48
Primogenial Man,	Neanderthal Type	72·7
,, ,,	Galley Hill ...	68·3
,, ,,	Cromagnon Type	64·2
Recent Man,	mean of 33 Races ...	62·36.

If we suppose the mean of each group to be nearest its primitive form, then *Tarsius* (76·35) is nearest to that form, and it has spread out to the *Chiromyrdae* and *Lorisinae* on the one hand with large heads relative to the busts and to the *Indrisinae* and *Lemurinae* on the other with small heads relative to the busts. In the *Cebidae* regarding the Head-Bust Ratio only the primitive form lies between *Brachyurus* (67·35) and *Pithecia* (65·25) and the development has been to the *Hapalinae* with relatively large heads on the one hand and to *Ateles* with a relatively small head (55·9) on the other. In this extreme Head-Bust Ratio we must compare *Dryopithecus rhenanus*

TABLE XXXII. *Table of the Head-Bust Ratio* = 100 *Vertical Diameter of Head/Bust Length.*

	Race	Head-Bust Ratio ♂	Head-Bust Ratio ♀	
Lemuroids	*Chiromyrdae*	84·1 (2)		Mean 76·73
	Lorisinae	83·8 (6)		
	Galaginae	78·0 (6)		
	Tarsiidae	76·35 (2)		
	Lemurinae	70·4 (18)		
	Indrisinae	67·75 (8)		
Cebidae	*Hapalinae*	76·7 (16)		Mean 66·81
	Nyctipithecinae	74·0 (8)		
	Cebus	69·2 (6)		
	Brachyurus	67·35 (2)		
	Pithecia	65·25 (2)		
	Lagothrix	63·7 (2)		
	Mycetes	62·35 (2)		
	Ateles	55·9 (4)		
Simiadae	*Cercopithecus*	75·4 (8)		Mean 70·04
	Semnopithecus	73·5 (10)		
	Macacus	70·0 (14)		
	Cynocephalus	66·8 (8)		
	Cercocebus	64·5 (4)		
Simiinae	Gorilla	55·9 (51)		Mean 59·48
	Chimpanzee	59·6 (25)		
	Orang-utan	60·5 (6)		
	Gibbon	61·9 (24)		
	Dryopithecus rhenanus	55·3 (1)		
	Pithecanthropus erectus	60·8 (1)		
	Spy	73·2 (1)		Mean (6) 72·7 Neanderthal Type
	Neanderthal	83·7 (1)		
	La Chapelle-aux-Saints	62·5 (1)		
	Galley Hill	68·3 (1)		
	Homo mousteriensis (*Hauseri*)	71·2 (1)		
	Homo aurignacensis (*Hauseri*)	59·4 (1)		

Race	Head-Bust Ratio ♂	Head-Bust Ratio ♀
[Rothwell English	{74·7 (174)}	{75·3 (126)}]
Portuguese]	{71·7 (134)}	{71·3 (126)}]
Chinese	67·1 (6)	
Malays	65·5 (118)	
Turks	64·9 (18)	
Phoenicians and Carthaginians	64·7 (16)	
Negritos	64·2 (42)	
Cromagnon	64·2 (13)	
Patagonians	63·9 (101)	
Melanesians	63·8 (80)	
Polynesians	63·6 (18)	
Gauls and Gallo-Romans	63·6 (78)	
Japanese	63·6 (92)	
Neolithic Swiss Dwarfs	63·5 (3)	
Franks, Burgundians and Merovingians	63·0 (70)	
Mediaeval French	63·5 (183)	
Ancient Slavs	62·8 (43)	
Indo-Chinese	62·7 (16)	
Fuegians	62·4 (12)	
Bronze Age Europeans	62·3 (46)	
French Neolithics	61·9 (240)	
Berbers and Guanches	61·7 (94)	
Ancient Egyptians	61·5 (22)	
Negroes (Various)	61·5 (97)	
17th century Londoners	61·32 (411)	60·70 (306)
Hindoos	61·3 (18)	
Aino	61·2 (8)	
Ancient Equatorial and S. American Indians	61·1 (452)	
Modern Germans	60·9 (18)	
Modern French	60·8 (69)	
Australians (Pearson)	60·6 (2)	77·7 (!) (2)
Eskimo	60·4 (13)	
Canary Islanders	60·3 (287)	
Laplanders	60·2 (6)	
Basques	59·9 (35)	
Veddahs	57·9 (2)	

N.B. In this Table we have had chiefly to depend on Rodriguez's measurements, as he is the only author who has measured the length of the Capito-collar Axis or Bust as we have done. Parsons for the Rothwell English, and Tamagnini and de Campos for the Portuguese, who have followed him, are dealing with a wholly different bust length.

(55·3) and not the Gibbon (61·9) with *Ateles*. In the *Simiinae* it is the Chimpanzee (59·6) which approaches closest to the Anthropoid mean, and after that the Orang. The extreme developments are on the one side the Gorilla (55·9) and on the other the Gibbon (61·9). This result is only reached, however, by pooling a large number of measurements from various sources, and we prefer our own results which give for Gorilla 60·1 and for Gibbon 58·2, thus inverting the above order and placing the Gibbon nearer, as we think it should be, to *Dryopithecus rhenanus*. There is probably not much difference in the Anthropoids for the Head-Bust Ratio. Turning to Man we see that for Recent Man the mean is almost exactly that of the Fuegians (62·4), which may be suggested therefore as the primitive type, the protoneoteric type. From this the evolution has been to the relatively small heads of the Basques on one side and to the relatively large heads of the Chinese and Malays on the other. Primogenial Man is by no means easy to fit into the general scheme. Galley Hill is here as in a number of other characters intermediate between Neanderthal and Cromagnon, and the series Neanderthal Type, Galley Hill, Cromagnon Type, Recent Man is a very satisfactory one. But Neanderthal stands at the opposite extreme to the Anthropoids. The succession: *Lemuroidea, Simiadae, Simiinae* is quite good, but Primogenial Man carries us back to something between *Simiinae* and *Simiadae* if not in the case of the Neanderthal Type to something between the latter and the Lemuroids. It is another case of the scission of the primates or the reversion of Recent Man from Primogenial Man to more apelike proportions.

(iv) ROBUSTICITY AND ELLIPTICITY OF THE FEMORAL HEAD.

(*a*) The Robusticity of the Head is measured by the ratio of the sum of the vertical and horizontal diameters of the head to the oblique length, this ratio as usual being multiplied by 100. The accompanying table summarised in the following means indicates a marked serial order of development:

Lemuroidea (42 femora) ...	15·62
Cebidae (42 femora)	16·88
Simiadae (44 femora)	17·59
Greater Anthropoids (3 genera)	24·87
Neanderthal Type Man ...	25·0
Galley Hill Man	23·3 ?
Cromagnon Type Man ...	21·79
Recent Man (71 racial groups)	20·72
17th century Londoners ...	20·60.

To these we may add for comparison:

Dryopithecus rhenanus ...	16·7
Gibbon	16·8
Ateles	16·7.

These results can leave no doubt in our mind that the Greater Anthropoids are closer by far in this character to Primogenial Man than the Gibbons, fossil or recent.

Indeed the femur alone would provide small evidence that the gibbon is properly included in the *Simiinae.* We have indeed repeatedly to leave him on one side in taking averages for this group. His nearest resemblance lies in this as in a variety of other characters to *Ateles.* This may be due to the development enforced by a common method of life, but it also suggests that the ancestor of the gibbon is rather to be sought in a common ancestor of *Cebidae* and *Simiadae* than in a common ancestor of *Simiadae* and *Simiinae.* It is certainly difficult to believe that the troglodytic femur of Primogenial Man—and we may almost give that of Recent Man the same title—should have sprung from a gibbon-like rather than a chimpanzee-like ancestor. As is so frequently the case the Neanderthal Type overshot the mark, and we have a descent possibly through a Galley Hill Type, almost certainly through the Cromagnon Type to the less but still great robusticity of Recent Man, for whom our 17th century Londoners will stand very well as type.

The highest robusticity in Recent Man is exhibited by the Oriental Type of the Asiatics and by certain fringe races. Modern European races follow; they seem to be more robust than their prehistoric and mediaeval forbears. Lastly we have modern primitive races from Polynesians and Maori to Veddahs, Australians and Andamans at the extreme. In this character as in several others the relation which has been suggested between Australian and Primogenial Man of Type I certainly finds no justification. We may classify for this rather important femoral index as follows:

Hypereurostic: all values 24 and above,
Macroeurostic: all values 21·5 and under 24,
Mesoeurostic: all values 20·5 and under 21·5,
Microeurostic: all values 19·5 and under 20·5,
Hypoeurostic: all values under 19·5.

Only the Greater Anthropoids and Primogenial Man provide hypereurostic races; macroeurostic are Lapps, Eskimos and Fuegians, Japanese and Chinese. Modern and Ancient Europeans are chiefly mesoeurostic; Malays, Polynesians, Melanesians, Maori and Negroes are microeurostic, while the hypoeurostic class embraces Veddahs, Australians and Andamans. Thus the most primitive of existing races have—contrary, perhaps, to expectation—the least robust femora.

(*b*) The Ellipticity of the Head is measured by 100 × the ratio of Horizontal to Vertical Diameter of Head. Here the summary of means gives us:

Lemuroidea (42 femora)	102·27
Cebidae (42 femora)	100·21
Simiadae (44 femora)	99·45
Dryopithecus rhenanus (1)	99·6
Simiinae (including Gibbon)	100·03
Neanderthal Type (6)	98·4
Cromagnon Type (13)	100·0
Recent Man (47 racial groups)	99·35
17th century Londoners	99·0.

TABLE XXXIII. *Robusticity and Ellipticity of Femoral Head.*

	Race	Robusticity of the Head			Race	Ellipticity of the Head		
		Value ♂ + ♀		Source		Value ♂ + ♀		Source
Lemuroids	*Tarsiidae*	12·0 (2)	Mean 15·62	Present Authors	*Tarsiidae*	108·1 (2)	Mean 102·27	Present Authors
	Indrisinae	14·2 (8)			*Chiromyrdae*	104·35 (2)		
	Galaginae	15·8 (6)			*Galaginae*	103·6 (6)		
	Lemurinae	16·5 (18)			*Indrisinae*	100·2 (8)		
	Chiromyrdae	16·9 (2)			*Lemurinae*	99·2 (18)		
	Lorisinae	18·3 (6)			*Lorisinae*	98·2 (6)		
Cebidae	*Pithecia*	14·4 (2)	Mean 16·88	Present Authors	*Lagothrix*	101·8 (2)	Mean 100·21	Present Authors
	Brachyurus	15·05 (2)			*Nyctipithecinae*	100·7 (8)		
	Nyctipithecinae	16·3 (8)			*Cebus*	100·2 (6)		
	Ateles	16·7 (4)			*Hapalinae*	100·1 (16)		
	Hapalinae	17·0 (16)			*Pithecia*	100·0 (2)		
	Cebus	17·5 (6)			*Ateles*	100·0 (4)		
	Mycetes	17·75 (2)			*Brachyurus*	99·55 (2)		
	Lagothrix	20·35 (2)			*Mycetes*	99·3 (2)		
Simiidae	*Cercocebus*	15·55 (4)	Mean 17·59	Present Authors	*Cercocebus*	100·6 (4)	Mean 99·45	Present Authors
	Semnopithecus	17·1 (10)			*Semnopithecus*	99·35 (10)		
	Cercopithecus	17·9 (8)			*Macacus*	99·3 (14)		
	Cynocephalus	18·5 (8)			*Cercopithecus*	99·1 (8)		
	Macacus	18·9 (14)			*Cynocephalus*	98·9 (8)		
	Dryopithecus rhenanus	16·7 (1)		Cast	*Dryopithecus rhenanus*	99·6 (1)		
Simiinae	Orang-utan	26·4 (8)	Mean 24·87	Various	Gorilla	100·0 (5)	Mean 100·03	Present Authors
	Gorilla	25·6 (48)		„	Gibbon	100·7 (2)		
	Chimpanzee	22·6 (27)		„	Chimpanzee	99·9 (25)		Various
	Gibbon	16·8 (24)		„	Orang-utan	99·5 (6)		„
	Pithecanthropus erectus	19·7 (1)		Dubois	*Pithecanthropus erectus*	97·8 (1)		Dubois

Robusticity and Ellipticity of Femoral Head (continued).

	Race	Robusticity of the Head Value ♂	♀	Source	Race	Ellipticity of the Head Value ♂	♀	Source
Primogenial Man	Spy	25·9 (1)	Mean Neanderthal (6) 25·0	Cast	*Homo aurignacensis* (*Hauseri*) ...	104·9 (?) (1)		Klaatsch
	Homo mousteriensis (*Hauseri*)	25·2 (1)		,,	Cromagnon	100·00 (13)		Rodriguez
	La Chapelle-aux-Saints ...	24·8 (1)		Photographs etc.	*Homo mousteriensis* (*Hauseri*) ...	99·4 (1)	Mean Neanderthal (6) 98·4	Cast
	Neanderthal	24·1 (1)		Cast	La Chapelle-aux-Saints	99·7 (1)		Photographs etc.
	Galley Hill	23·3 (1)		,,	Spy	98·6 (1)		Cast
	Cromagnon	21·79 (13)		Rodriguez	Neanderthal	97·8 (1)		,,
	Homo aurignacensis (*Hauseri*)	19·9 (1)		Klaatsch	Galley Hill	(?)		—
Recent Man	Laplanders I	22·19 (6)		Rodriguez	Fossil Negroid Grimaldi ...	102·83 (3)		Rodriguez
	,, II	[19·94 (4)]		Hepburn	Aino	100·99 (8)		,,
	Japanese	22·02 (92)		Rodriguez	Eskimo	100·39 (13)		,,
	Chinese	21·93 (6)		,,	Negroes I	100·13 (12)		Bumüller
	Turks	21·94 (18)		,,	Melanesians	100·00 (80)		Rodriguez
	Fuegians I	21·79 (10)		Hultkrantz	Maori	100·00 (4)		Mollison
	,, II	21·20 (12)		Rodriguez	Polynesians	99·96 (18)		Rodriguez
	Australians	21·7 (2)	21·3 (2)	Pearson and Bell	Indonesians	99·93 (14)		,,
	Eskimo I	21·55 (13)		,,	Negritos	99·89 (42)		,,
	,, II	20·01 (4)		Hepburn	Berbers and Guanches	99·86 (94)		,,
	Rothwell English	[21·49 (174)	20·28 (103)]	Parsons	Indians	99·80 (48)	100·20 (33)	Antony and Rivet
	Modern Bolognese	[21·46 (24)	21·19 (24)]	Zanolli	Malays	99·78 (118)		Rodriguez
	Ancient Slavs	21·32 (43)		Rodriguez	Negroes II	99·78 (97)		,,
	Patagonians	21·22 (101)		,,	Ancient Equatorial and South American Indians	99·75 (452)		,,
	Gauls and Romano-Gauls ...	21·24 (78)		,,	Fuegians I	99·72 (12)		,,
	Modern French I	[21·21 (62)	20·60 (38)]	Various	,, II	99·15 (10)		Hultkrantz
	,, ,, II	20·93 (69)		Rodriguez	Modern Germans	99·53 (18)		Rodriguez
	Modern Germans	21·09 (18)		,,	Men of Bronze Age, France ...	99·50 (46)		,,
	Romano-British	[21·08 (6)]		Hepburn	Ancient Egyptians	99·43 (22)		,,
	Franks and Burgundians ...	21·07 (30)		Rodriguez	Canary Islanders	99·43 (287)		,,
	Neolithic Swiss (Chamblands) ...	[21·06 (15)	20·39 (9)]	Schenk	Modern French	99·36 (69)		,,
	17th century Londoners ...	21·02 (335)	20·17 (246)	Authors	Chinese	99·36 (6)		,,
	Mediaeval French	21·01 (183)		Rodriguez	Indo-Chinese	99·36 (16)		,,
	Ancient South and Equatorial American Indians	20·97 (452)		,,	Turks	99·36 (18)		,,
	Neolithic Man, Châlons-sur-Marne	[20·97 (23)	19·98 (9)]	Manouvrier	Patagonians	99·36 (101)		,,

Race	Robusticity of the Head: Value ♂	♀	Source
Ainos	20·93 (8)		Rodriguez
Men of Bronze Age	20·92 (46)		,,
Merovingians	20·89 (40)		,,
Ancient Etruscans	[20·86 (18)	20·05 (15)]	Sergi
Ancient Persians from Anau	20·85 (2)		Mollison
Indonesians	20·78 (14)		Rodriguez
Basques	20·75 (35)		,,
Phoenicians and Carthaginians	20·74 (16)		,,
Modern Portuguese	[20·72 (264)	20·03 (250)]	de Campos
Bajuvars, Swabians and Alemanns from Row Graves	20·70 (28)	20·50 (12)	Lehmann-Nitsche
French Neolithics	20·64 (240)		Rodriguez
Modern Swiss	20·63 (22)		Schwerz
Neolithic Swiss Dwarfs	20·59 (4)		,,
Indo-Chinese	20·59 (16)		Rodriguez
Neolithic Men from Montigny-Esbly	[20·45 (10)	19·91 (4)]	Manouvrier and Antony
Malays	20·32 (118)		Rodriguez
Berbers and Guanches	20·31 (94)		,,
Polynesians	20·29 (18)		,,
Ancient Egyptians	20·11 (22)		,,
Fossil Negroid from Grimaldi	20·05 (3)		,,
Maori I	[19·94 (12)	21·46 (3)]	Hepburn
,, II	19·64 (4)		Mollison
Canary Islanders	19·81 (287)		Rodriguez
Negritos	19·81 (42)		,,
Negroes I	19·69 (97)		,,
,, II	[19·01 (10)	18·38 (3)]	Hepburn
Melanesians	19·64 (80)		Rodriguez
Hindoos I	19·52 (18)		,,
,, II	[19·40 (6)	17·85 (2)]	Hepburn
Veddahs	19·32 (2)		Rodriguez
Australians	[18·59 (12)	16·19 (2)]	Hepburn
Andamans	[18·50 (8)	19·11 (4)]	,,

Race	Ellipticity of the Head: Value ♂	♀	Source
Phoenicians and Carthaginians	99·33 (16)		Rodriguez
Hindoos	99·31 (18)		,,
Modern Bolognese	99·30 (24)	99·00 (24)	Zanolli
Neolithic French	99·22 (240)		Rodriguez
Ancient Slavs	99·03 (43)		,,
Merovingians	98·98 (40)		,,
17th century Londoners	98·86 (335)	99·10 (216)	Pearson and Bell
Veddahs	98·83 (2)		Rodriguez
Japanese	98·82 (92)		,,
Ancient Persians from Anau	98·75 (2)		Mollison
Basques	98·73 (35)		Rodriguez
Franks and Burgundians	98·71 (30)		,,
Laplanders	98·64 (10)		,,
Gauls and Romano-Gauls	98·51 (78)		,,
Mediaeval French	98·44 (183)		,,
Ancient Etruscans	97·97 (20)	98·37 (18)	Sergi
Bajuvars, Swabians and Alemanns from Row Graves	97·00 (28)	97·70 (12)	Lehmann-Nitsche
Australians	96·8 (2)	98·7 (2)	Pearson and Bell

Single entries in the "value" column denote either ♂ + ♀ or sex not stated.

Here the evolutionary drift from Lemuroids to Recent Man appears to have been from a vertical diameter relatively less than the horizontal to one relatively greater. The *Simiinae* make an apparent exception, which is supported by the fossil Gibbon, but Neanderthal Type carries on the decrease in the index, and, as so frequently occurs, appears to overshoot the mark, and there is a return towards the apelike in the Cromagnon and Recent Man femora. It is, perhaps, worth remarking that *Tarsius* has the least and Primogenial Man the greatest robusticity, that *Tarsius* has the greatest index of ellipticity of the head and Primogenial Man (Neanderthal Type) the least! If we suppose *Tarsius* on the direct line of man's ascent, then these femoral features alone compel us to insert troglodyte ancestors.

It would thus seem that the perfection of the head as a Hooke joint is less in modern Europeans than in the apes and in Primogenial Man. Except in certain "fringe" races—Maori, Eskimo and Aino—the vertical diameter always appears to be greater than the horizontal. But the ellipticity is less for modern primitive than it is for modern civilised races, Polynesians, Malays, Negroes and American Indians having small ellipticity. As we have previously stated, however, far larger records and probably greater standardisation and accuracy of measurement are necessary before ellipticity of femoral head can be given much weight as a racial character.

(v) CAPITO-COLLAR AXIS OR BUST LENGTH.

It is difficult to find comparatives for our capito-collar axis, *i.e.* length from centre of head to coaxial point. A good many writers measure from centre of head to the spiral line. The difficulty of this measurement is great. In the first place it has relation only to the anterior face, and a good measurement of the bust should be free of aspect; in the next place the spiral line is an area and for any useful measurement some definition is required of how this area is to be reduced to a line; lastly a length must be from one point to a second point, and not to a line, unless we have again a clear definition of how to fix a point in that line. It will not do to say that point where the axis of the neck meets the spiral for then the axis of the neck needs definition and, further, that axis does not meet the spiral line. We are quite aware that our capito-collar axis appears to exceed the epiphysis and to encroach on the diaphysis. But this is to some extent the result of regarding the bone from the *anterior* face, and not the posterior; and it certainly does appeal to a point—the coaxial point—which can be determined with some degree of exactitude. It must be noted that the apparent neck is at least a centimetre longer on the posterior than the anterior face and that on this account the capito-collar axis is a better estimate of the length of neck and head than those who consider the femur solely from its anterior face are likely to give it credit for being. Parsons[1], and again Tamagnini and De Campos[2], need to have 11 to 12 mm. added to their length of neck to render it

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[1] Bibl. 111, p. 241.

[2] These Portuguese writers term the length of head and neck "Comprimento do colo," which seems like Parsons' "Length of the Neck" to exclude any name for the true length of the neck itself: see Bibl. 118, p. 9, 10°.

TABLE XXXIV. *Racial Values of Capito-collar Axis and Length of Neck.*

	Race	No.	Capito-collar Axis			Length of Neck*		
Lemuroidea	*Tarsiidae*	2	4·85		Mean 10·33	3·05		Mean 6·38
	Galaginae	6	5·5			3·5		
	Lorisinae	6	8·5			4·9		
	Chiromyrdae	2	12·25			7·1		
	Lemurinae	18	15·3			9·4		
	Indrisinae	8	15·6			10·3		
Cebidae	*Hapalinae*	16	7·5		Mean 17·07	4·6		Mean 11·54
	Nyctipithecinae	8	9·4			5·9		
	Pithecia	2	14·3			9·65		
	Cebus	6	15·1			9·9		
	Brachyurus	2	17·3			11·5		
	Lagothrix	2	17·8			11·65		
	Mycetes	2	21·65			14·9		
	Ateles	4	33·5			24·2		
Simiadae	*Cercopithecus*	8	17·1		Mean 24·55	10·75		Mean 16·12
	Macacus	14	23·5			15·3		
	Semnopithecus	10	23·8			15·3		
	Cercocebus	4	26·2			17·75		
	Cynocephalus	8	32·15			21·5		
	Dryopithecus rhenanus	1	43·4			31·4		
Simiinae	Gorilla	7	77·4		Mean 62·87	54·2		Mean 44·10
	Chimpanzee	2	62·4			44·3		
	Orang-utan	5	48·8			33·8		
	Gibbon	2	26·05			18·5		
	Pithecanthropus erectus	1	74·0			51·5		
Primogenial Man	La Chapelle-aux-Saints	1	82·5		Mean for 6 Neanderthal Type 75·0	56·7		Mean for 6 Neanderthal Type 46·4
	Spy	1	76·2			48·3		
	Galley Hill	1	72·2			47·6		
	Homo aurignacensis (*Hauseri*)	1	69·0			48·5		
	Homo mousteriensis (*Hauseri*)	1	67·0			43·2		
	Neanderthal	1	64·5			37·5		
	Cromagnon	13	84·7			57·6		
	RECENT MAN:		♂	♀		♂	♀	
	Modern Germans	(18)	79·8	80·0(!)		55·5	55·7(!)	
	Gauls and Romano-Gauls	(78)	78·4	70·7		53·8	48·5	
	Mediterranean Race	32	78·3	71·6		54·1	49·5	
	Modern French	69	77·9	75·1		54·3	52·3	
	RECENT MAN (*continued*):		♂	♀		♂	♀	
	Rothwell English	178, 105	77·7	67·5		53·2	46·2	
	17th century Londoners	456, 349	77·12	67·89		53·7	47·2	
	Franks and Burgundians	30	77·1	71·0		52·7	48·5	
	Mediaeval French	183	77·1	71·0		53·3	49·1	
	Patagonians	101	77·0	69·1		52·4	47·0	
	Portuguese	134, 126	76·6	67·3		53·3	47·1	
	Ancient Slavs	43	75·4	70·0		51·7	48·0	
	Neolithic Europeans	240	74·4	68·0		51·4	48·0	
	Veddahs	2	74·3	—		52·8	—	
	Laplanders	6	74·3	—		51·9	—	
	Basques	35	74·2	—		51·9	—	
	Merovingians	40	74·1	68·3		50·9	46·9	
	Negritos	42	74·1	56·6		50·3	38·4(?)	
	Berbers and Guanches	94	73·8	69·3		51·0	47·9	
	Ainos	8	73·8	66·3		51·2	46·0	
	Ancient Equatorial Indians	126	73·6	67·1		52·1	47·5	
	Canary Islanders	287	73·4	67·0		51·2	46·8	
	Fuegians	12	73·4	68·3		50·5	47·0	
	Eskimo	13	73·4	70·8		50·5	48·7	
	Negroes (? *locus*)	48	73·1	67·5		50·9	46·9	
	Bronze Age Europeans	46	72·6	64·0		50·0	44·1	
	Turks	18	72·6	—		49·1	—	
	New Guinea Negroes	16	72·4	—		49·7	—	
	Ancient Bolivians	51	72·2	65·6		50·4	45·9	
	Prehistoric Naqada Egyptians	43, 61	71·60	65·13		—	—	
	Ancient Egyptians	22	71·6	69·1		49·6	47·9	
	Japanese	92	71·5	65·5		48·7	44·7	
	Polynesians	18	71·5	66·7		48·8	45·5	
	Mozambique Negroes	13	71·0	66·2		48·9	45·6	
	Ancient Venezuelians	43	70·8	65·9		48·8	45·4	
	Phoenicians and Carthaginians	16	70·4	64·6		47·6	43·7	
	Peruvian Indians	75	70·1	66·0		48·1	45·2	
	Ancient Mexicans	22	69·7	64·7		47·5	44·1	
	Californian Indians	122	69·1	64·0		47·5	44·0	
	Indo-Chinese	16	69·5	67·4		47·7	46·3	
	Congolese	20	69·3	62·5		47·9	43·2	
	Melanesians	80	68·5	63·5		46·6	43·2	
	Maori	5	68·2			48·6		
	Chinese	6	67·6	65·8		45·0	43·7	
	Indonesians	14	67·5	60·7		45·3	40·8	
	Hindoos	18	66·4	65·3		46·0	45·3	
	Malays	118	65·6	59·8		44·1	40·2	
	Neolithic Swiss Dwarfs	4	59·8			40·8		

* This measurement is the conventional one = Capito-collar Axis – half Vertical Diameter of Head.

comparable with our capito-collar axis. Warren obtained by appreciation of coaxial point first on anterior and then on posterior face and averaging his results values for neck + head in the prehistoric Egyptian or Naqada femora[1]. A longer list of racial values may be obtained by reconstruction from Rodriguez's published results, and these we have used to the full as they appear most in accordance with our own measurements, although Rodriguez does not state very fully how the capito-collar length which must have been used to obtain his index was determined. We have added our own determinations of this length for the apes and Primogenial Man, thus providing the table on p. 361.

Summarising this table as before we find:

	Length of Bust (Capito-collar Axis)	*Length of Neck* (Capito-collar Axis less ½ Vertical Diameter of Head)
Lemuroids	10·33	6·38
Cebidae	17·07	11·54
Simiadae	24·55	16·12
Recent Gibbon	26·05	18·5
Dryopithecus rhenanus	43·4	31·4
Greater Anthropoids	62·87	44·10
Neanderthal Type	75·0	46·4
Cromagnon Type	84·7	57·6
Recent Man	♂ (46) 72·87, ♀ (41) 67·14	♂ 50·23, ♀ 46·07
Recent Man (87 and 85 racial groups)	♂ + ♀ 70·17	♂ + ♀ 48·27
17th century Londoners	♂ 77·12, ♀ 67·89	♂ 53·7, ♀ 47·2
" " "	♂ + ♀ 73·12	♂ + ♀ 50·88

We see that this summary marks out exactly as each absolute length has done the steady increase in size up to the Greater Anthropoids. The *Cebidae* as usual move in development from a Lemuroid ancestry, in the same direction as the *Simiadae* but less markedly; they belong to an earlier stage than the *Simiadae*. Then comes the great advance in size with Neanderthal Man, still more emphasised in Cromagnon from which point Recent Man has reverted to a more Neanderthal, if not a more ape-like size. Of Recent Man it is noteworthy that the longest busts and necks are to be found in the modern Europeans and their historic ancestors[2]. Absolutely short busts and necks in the Chinese, Melanesians and Malays. The Negroes followed by Eskimo and Fuegians appear to be for these characters nearest to type. As usual, however, beyond illustrating the broad line of development but little satisfaction can be obtained from absolute measurements. In this case they only evidence the necessity for a troglodyte rather than a hylobatic ancestry for Man. We turn then to the relative size of the bust.

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[1] Bibl. 77, p. 137.

[2] This result would be shaken if we could place any trust in the *four* Australian femora in our own possession which give:

Capito-collar Length ♂ 81·1 (2), ♀ 59·05 (2),
Length of Neck ... ♂ 56·6 (2), ♀ 37·7 (2).

(vi) PRIMARY AND SECONDARY BUST RATIOS.

The Primary Bust Ratio is 100 × capito-collar length divided by the maximum length and the Secondary Bust Ratio replaces the maximum by the oblique length. These ratios are important, but it is almost impossible to obtain good comparative data. Rodriguez's measurements are really the only results which can with profit be placed in the same table as our own. Evangeli-Tramond[1] measures the "Longeur du col" of French femora in 81 cases. He neither describes his method of measurement, nor states his units of measurement. Supposing that 8·4 in the column headed "Longeur du col" means 8·4 cms., we find from his tables:

Length of Neck.

♂ (40) 89·18 mm. ♀ (41) 74·54 mm.

He further gives (p. 19) for mean length of femur:

♂ 43·65 ♀ 39·7.

We presume that these refer to the oblique length in cms. In this case the order of his Secondary Bust Ratio would be

♂ 20·4 ♀ 18·8.

Such excessive values for the length of neck and the Bust Ratio are not to be found in any race of mankind. The Bust Ratio for the males approaches that of the gorilla, and for the females that of the orang-utan. Clearly he has not measured to the coaxial point and *à fortiori* not to the spiral line. Rodriguez gives for modern French ♂ + ♀ 17·27, which is in keeping with our ♂ + ♀ 17·11 for 17th century Londoners. Again the difference between the sexes for both absolute and relative neck measurements as given by Evangeli-Tramond is very suspicious. The following table shows the sexual differences in the Bust Ratios obtained from the data of various authorities.

It will be seen that Evangeli-Tramond and Parsons stand alone in their extreme emphasis of sexual difference in the Bust Ratio. The more reliable measurements do not show more than half a point, but Evangeli-Tramond has 1·7 and Parsons even 3·0 sexual difference. We believe that this difference is not real, but arises from over-emphasis of the bust size, in particular of the size of the head in sexing[2].

It must not, however, be supposed that the following table gives true *racial* differences. We obtain the coaxial point by diagraphic methods, so we believe did Rodriguez and probably Antony and Rivet. Warren obtains it by appreciation, averaging for both anterior and posterior faces. Koganei measures to the trochanteric crest, Evangeli-Tramond has done something of an individual nature and gives no account of it. Tamagnini and de Campos appear to have used the spiral line, but neither they nor Parsons state clearly what they have done. Accordingly for comparative purposes we have rejected all but Rodriguez's data. We have combined as he does the sexes, using only the Secondary Bust Ratio. Probably Mollison for a few Maori femora and Schwerz for the neolithic Swiss Dwarfs may be safely included.

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[1] Bibl. 65.

[2] The Portuguese data confirm our London data in making the value of the Bust Ratio greater on the left than on the right side. Parsons gets no uniformity of this kind, which makes us still further distrust his results for the femoral neck.

TABLE XXXV. *Primary and Secondary Bust Ratios.*

Group		Authority	Primary Bust Ratio			Secondary Bust Ratio		
			♂		♀	♂		♀
Lemuroids	*Tarsiidae*	Pearson & Bell	7·55 (2)	Mean 10·13	♂ + ♀	7·55 (2)	Mean 10·16	♂ + ♀
	Chiromyrdae	,,	9·8 (2)		,,	9·8 (2)		,,
	Galaginae	,,	10·05 (6)		,,	10·1 (6)		,,
	Indrisinae	,,	10·6 (8)		,,	10·6 (8)		,,
	Lorisinae	,,	11·0 (6)		,,	11·0 (6)		,,
	Lemurinae	,,	11·8 (18)		,,	11·8 (18)		,,
Cebidae	*Nyctipithecinae*	Pearson & Bell	10·7 (8)	Mean 12·74	♂ + ♀	10·7 (8)	Mean 12·76	♂ + ♀
	Pithecia	,,	11·05 (2)		,,	11·05 (2)		,,
	Brachyurus	,,	11·15 (2)		,,	11·2 (2)		,,
	Hapalinae	,,	11·2 (16)		,,	11·2 (16)		,,
	Cebus	,,	12·7 (6)		,,	12·7 (6)		,,
	Mycetes	,,	14·25 (2)		,,	14·25 (2)		,,
	Ateles	,,	15·0 (4)		,,	15·0 (4)		,,
	Lagothrix	,,	15·9 (2)		,,	15·95 (2)		,,
Simiadae	*Semnopithecus*	Pearson & Bell	11·7 (10)	Mean 12·80	♂ + ♀	11·7 (10)	Mean 12·84	♂ + ♀
	Cercocebus	,,	11·9 (4)		,,	12·0 (4)		,,
	Cercopithecus	,,	12·1 (8)		,,	12·1 (8)		,,
	Cynocephalus	,,	14·0 (8)		,,	14·0 (8)		,,
	Macacus	,,	14·3 (14)		,,	14·3 (14)		,,
Simiinae	Gibbon	Pearson & Bell	13·4 (2)	Mean 14·25	♂ + ♀	13·4 (2)	Mean 14·3	♂ + ♀
	Dryopithecus rhenanus	,,	15·1 (1)		♂ or ♀	15·2 (1)		♂ or ♀
	Chimpanzee	,,	19·85 (2)	Mean 21·08	—	20·05 (2)	Mean 21·20	—
	Orang-utan	,,	20·6 (5)		♂ + ♀	20·7 (5)		♂ + ♀
	Gorilla	,,	22·8 (4)		22·1 (3)	22·85 (4)		22·3 (3)
17th century Londoners		Pearson & Bell	17·24 (427)		16·66 (326)	17·35 (405)		16·78 (305)
Paltacalo Indians		Antony & Rivet	17·93 (60)		17·37 (47)	18·13 (60)		17·61 (47)
Australians		Pearson & Bell	17·95 (2)		14·75 (2)	18·25 (2)		14·9 (2)
Naqada Egyptians		Warren	15·90 (45)		15·40 (87)	16·02 (45)		15·55 (87)
Portuguese		Tamagnini & de Campos	14·42 (134)		13·90 (126)	14·53 (134)		14·10 (126)
Japanese		Koganei	16·81 (20)		16·32 (20)	—		—
Aino		,,	16·65 (42)		16·22 (24)	—		—
French (Modern)		Evangeli-Tramond	—		—	20·43 (40)		18·78 (41)
Rothwell English		Parsons	16·57 (160)		13·50 (102)	16·69 (160)		13·58 (102)

A comparison of our values for Primary and Secondary Indices suffices to demonstrate that it is quite idle to take *both*. It only remains for femoralogists to settle which they will take, so that future investigators may be saved from the labour of taking both. The difference in the Lemuroids and monkeys is never greater than ·05, in the Anthropoids and Man it may amount to ·1 to ·2. Such differences

TABLE XXXV *bis*. *Table of the Secondary Bust Ratio* $= 100 \dfrac{\textit{Capito-collar Length}}{\textit{Oblique Length}}$.

	Race	No.	Value (♂ + ♀)	
Simiinae	Gorilla	46	22·9	20·83
	Orang-utan	6	20·7	
	Chimpanzee	25	18·9	
	Gibbon	24	13·6	
	Pithecanthropus erectus	1	16·4	
Primogenial Man	La Chapelle-aux-Saints	1	19·2	
	Man of Spy	1	17·9*	
	Homo mousteriensis (*Hauseri*)	1	17·9	
	Galley Hill	1	17·5	
	Homo aurignacensis (*Hauseri*)	1	16·3	
	Neanderthal	1	14·8	
	Cromagnon	13	16·98	
Recent Man	Laplanders	6	18·56	
	Basques	35	17·42	
	Japanese	92	17·41	
	Modern Germans	18	17·36	
	Mediterranean Race	32	17·33	
	Eskimo	13	17·28	
	Modern French	69	17·27	
	Mediaeval French	183	17·17	
	Ancient Indians of Equatorial and South America	452	17·17	
	17th century Londoners	753	17·11	
	Ancient Slavs	43	17·06	

Race	No	Value (♂ + ♀)
RECENT MAN (*continued*):		
Gauls and Romano-Gauls	78	17·03
Aino	8	17·01
Maori	5	17·01
Turks	18	16·97
Bronze Age Europeans	46	16·82
Veddahs	2	16·79
Merovingians	40	16·76
Franks and Burgundians	30	16·75
Neolithic Europeans	240	16·74
Patagonians	101	16·66
Berbers and Guanches	94	16·48
Indo-Chinese	16	16·48
Canary Islanders	287	16·46
Ancient Egyptians	22	16·41
Chinese	6	16·40
Negroes (? *locus*)	48	16·28
Phoenicians and Carthaginians	16	16·08
Neolithic Swiss Dwarfs	4	16·03
New Guinea Negroes	16	16·00
Hindoos	18	15·97
Polynesians	18	15·95
Indonesians	14	15·84
Mozambique Negroes	13	15·79
Malays	118	15·54
Congolese	20	15·49
Negritos	42	15·43
Melanesians	80	15·40

* Rodriguez gives a value 19·9 for Man of Spy. This does not seem to us in accordance with the photographs or cast.

occurring in practice make no sensible changes in the racial order. Summarising our results as before we find[1]:

Lemuroids	10·16
Cebidae	12·76
Simiadae	12·84
Gibbons, fossil and recent	14·13
Greater Anthropoids	20·83
Neanderthal Type (6)	17·7
Galley Hill	17·5
Cromagnon Type (13)	16·98
Recent Man (38 racial groups)	16·62
17th century Londoners	17·11.

We see from these results that the relative size of the bust increased from the Lemuroids right up to the Greater Anthropoids. The practical equality of the indices of *Cebidae* and *Simiadae* suggests that the proportionate value of the bust was fixed before the separation of Old and New World monkeys. Man lies between Gibbon and Chimpanzee, being considerably nearer to the latter—another argument in favour of the femur of the protsimio-human being troglodytic. From the Neanderthal Type, however, there is a considerable fall through Galley Hill and Cromagnon to the mean of Recent Man (16·62). *Pithecanthropus erectus* is as usual purely human, in fact in the same group as the Chinese. The Laplanders possess the relatively longest bust; the shortest busts are those of the negroid races. We may divide all femora into five classes according to the value of their bust ratio, namely:

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[1] We may note that for the relative bust length the type is given by the *Galaginae* for the Lemuroids, by *Cebus* for the *Cebidae*, by *Cercopithecus* for the *Simiadae* and by the Orang for the *Simiinae*.

Hyperdolicho-auchenic	above 17·60
Dolicho-auchenic ...	17·60 to 16·90
Meso-auchenic ...	16·90 to 16·20
Brachy-auchenic ...	16·20 to 15·50
Hypobrachy-auchenic	below 15·50.

The hyperdolicho-auchenic class contains the Greater Anthropoids, Neanderthal Man and of Recent Man only the Laplanders. The dolicho-auchenic class contains a large portion of modern Europeans but also the Japanese, Aino, and Maori and American Indians. The meso-auchenic class the early historic and prehistoric Europeans, the Patagonians and Chinese. The brachy-auchenic class the bulk of the Negroes, the Malays and Polynesians, while the hypobrachy-auchenic class contains the remainder of the Negroes and the Melanesians as well as the Gibbons and Lesser Apes. It will be seen that the divisions by no means correspond to well-marked racial distinctions, and it seems possible that this character may have been largely adapted to local conditions.

(vii) The Collar (or Cervical Angle).

We believe that with the existing absence of standardisation in the determination of the collar angle it is almost idle to exhibit the results obtained by different authorities in a single table. There appear to us grave objections to the determination of the coaxial point by the use only of the anterior face. Warren endeavoured to surmount this difficulty by considering the coaxial point on both faces. We believe that the collar angle found by appreciation of the capito-collar axis on either face, whether by use of threads or not, is subject to very great personal equation. The method we have used for the 17th century London femora, for the ape femora and the casts of the primogenial femora is a straightforward if laborious one, and admits of little personal equation. It is essentially the same as a dioptical one—the plane of projection being the standard vertical plane. Hence our method should agree with dioptical processes provided the axes of shaft and neck are selected in the same manner. It will be remembered that we do this by (*a*) the selection of two points, *i.e.* (i) the centre of the head (which must be determined by a tape measure and not taken "just above the fovea"), and (ii) the mid-trochlear point, and (*b*) the selection of two diameters, (i) the minimum vertical diameter of the neck, and (ii) the transverse platymeric diameter. The use of this projection method may raise 10° the angle obtained by the double aspect method. That is to say the change covers the entire racial variation in man or in the apes! After some consideration of the matter we have found that the projection method is very roughly about 4° in excess of the anterior face appreciation. We say very roughly because so much depends in the latter method on personal equation. Even if such a correction be reasonable we are in many cases quite unable to discover what method an osteologist has actually used for his determinations. Many seem to have approached the point without any apparent sense of the gruesome difficulties by which it is surrounded.

In order that the reader may not think we are exaggerating the present state of chaos in this important matter, let us look at a few results. Prochownick[1] (who, by the by, only appears to read his angles to the nearest 5°!) gives the collar angle for Australians as 119·0°. This places them about the bottom of the racial scale, and appears a not unreasonable position. Lustig[2]—almost as an aside, and without statement as to method used or as to the number dealt with—says that the collar angle of Australians is 130°, thus removing the Australians to about the top of the human scale! Martin in his table of this angle[3] reproduces Lustig and overlooks Prochownick and quite probably 130° will pass for years as the collar angle of the Australian femur! Now both our authorities may be in error, or both may be right if they have used one the double appreciation and the other a dioptical projection[4]. But we ask what progress can be made in interracial anthropometry until we have greater standardisation, greater appreciation of the real difficulties of our task, and a more detailed statement of methods? Such obscurities are not only attached to cases in which the data are sparse. Many writers have dealt with the collar angle of the modern French femur. Taking the French male we find the following values:

Evangeli-Tramond	124°
Bertaux	125°
Rodriguez	126°
Charpy...	127°
Rodet	131°

Similar results can be provided for the German tribes. Mikulicz gives Modern Viennese 127°; this agrees with Rodriguez's Modern "Germans" 127° and Bumüller's Modern Bavarians 127°, but differs hopelessly from Langer's Modern "Germans" 130° or Martin's Modern German Swiss 133°. We believe that the difference here exhibited is simply the result of an anterior face appreciation, and the use of what probably amounts to the dioptical method. Mollison's Ancient Persians (135°) and Maori (130°) are probably high for the same reason. On the other hand Rodriguez's long series of racial results are inter-comparable, and it would appear that Veddahs, Melanesians and Negritos have really a high collar angle; Fuegians, prehistoric American Indians and Guanches a low one like the Australians. Our own results indicate that Primogenial Man had a low collar angle and if Prochownick be correct the Australians resemble him in this respect while differing from him in so many other femoral characters. Modern Man has a mediocre collar angle, primitive races as a rule being one or other extreme. This scission of the low races by the high, which occurs in various femoral characters, cannot be disregarded, but it would be unwise at present to pursue its suggestiveness until at least standardised data are forthcoming. The anthropoids provide also a wide range—as wide as or indeed wider than in man—the gorilla at one end and the orang-utan at the other. Primogenial Man has a gorilloid collar angle, the Veddahs, Melanesians and Negritos follow the orang. In this respect there is hardly the marked distinction between Neanderthal Man and *Homo aurignacensis* that Klaatsch's analogy[1] (Neanderthal to gorilla and orang to *Homo aurignacensis*) demands. *Pithecanthropus erectus* and Galley Hill have modern values, while the Cromagnon Type—to judge by Rodriguez's value (126°·0) shows in this respect no differentiation from the modern European.

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[1] Bibl. 43.

[2] *Korrespondenz-Blatt für Anthropologie*, Jahrgang XLIV. S. 115, 1913.

[3] Bibl. 111 *bis*, S. 1028.

[4] There is another solution suggested by the four Australian femora in the Biometric Laboratory which give ♂ 120°·15 (2), ♀ 136°·25 (2), *i.e.* that there is among the Australian aborigines a marked sex difference, and that Prochownick had chiefly male and Lustig female bones. Lustig gives the trochanteric lengths, however, of 11 Australian femora (*l.c.* S. 114) of which the mean value is 418·5. If these femora are what he obtained his 130° from, such a mean would be rather male than female. On the other hand the mean proximal breadth of his material, 80·6, is very female unless his character be measured very differently from ours. We find ♂ 104·8 (2) and ♀ 87·25 (2). Against such a difference of measurement must be put that his mean for Neanderthal Type is 102·4 (5) while ours is 102·0 (7)—well in accord.

As we have stated, all comparisons are probably premature until we have definite standardisation, but even with the material as it stands it may be doubted whether a narrowly limited range of collar angle is closely associated with a particular species following a definite mode of progression or habit of life. Thus we have:

Primogenial Man, Neanderthal Type	115°·0
Gorilla	119°·8
Caroline Islanders	122°·3
Tigress[2]	123°·0
Fuegians	123°·5
Gibbon	123°·9
Deer[2]	125°·0
Modern English[2]	126°·0
Ass[2]	127°·0
Negroes	127°·1
Chimpanzee	127°·1
Japanese	128°·0
Puma[2]	128°·0
Malays	129°·0
Negritos	132°·6
Orang-utan	133°·0

a table which must give us "furiously to think," if we maintain both the accuracy of the measurements, and the evolutionary importance of the collar angle!

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[1] Bibl. 102 *ter*.

[2] Walmsley, Bibl. 113.

If we confine our attention purely to results of our own determination we have:

	Lemuroids (42)		114°·04
	Cebidae (42)		121°·17
	Simiadae (44)		116°·31
	Dryopithecus rhenanus (1)		125°·5
	Gibbon (2)		114°·5
Greater Anthropoids:	Gorilla (7)	114°·3	128°·9
	Chimpanzee (2)	133°·5	
	Orang-utan (5)	138°·7	
	Neanderthal Type (6)		115°·0
	Galley Hill (1)		126°·0
	Cromagnon Type (5)		126°·0
	Grimaldi Type (2)		128°·0
	17th century Londoners (805)		130°·2

This summary shows that the collar angle increased from the Lemuroids to the Greater Anthropoids, the *Cebidae*, however, advancing further than the *Simiadae*. The Recent Gibbon appears to have dropped on the fossil *Dryopithecus*, although 24 Gibbon collar angles collected from various sources and so determined probably by a variety of methods give nearly 124°, and correspond more closely with *Dryopithecus*. There comes the usual sudden drop with Neanderthal Man, followed by a rise through the later forms of Primogenial Man to Recent Man, whose collar angle has a value slightly on the gorilla side of the Chimpanzee, *i.e.* is troglodytic and not hylobatic. For the Lemuroids and *Cebidae*, we have again the *Galaginae* and *Cebus* respectively as types for this character. For the *Simiadae* we have, what is very exceptional, *Cynocephalus*, and for the *Simiinae* the very usual Chimpanzee.

Amid all the difficulties of the general table certain points appear to emerge clearly, namely:

(i) There are no significant differences in collar angle between modern European races.

(ii) There are no significant differences between modern Europeans and early historical Europeans.

(iii) There are no significant differences between early historical Europeans and neolithic European man[1].

But on the other hand:

(iv) There are marked differences between European palaeolithic and neolithic man.

(v) There are marked differences between the Australian, Pacific and American races and European races.

(vi) The African negro (127°·1) shows no significant difference from the European white. (This is confirmed by Manouvrier's value (126°·8) for the collar angle of the negro.)

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[1] Kuhff's measurements on small series are out of serial order, we believe, owing to personal equation. They are 4° to 5° below those of Rodriguez for similar groups.

TABLE XXXVI. *Collar Angle* (*i.e.* Angle of Neck and Shaft).

	Race	Value ♂	Value ♂ + ♀	Value ♀	Source
Lemuroids	*Tarsiidae*		109°·0 (2)	Mean 114°·04	Pearson and Bell
	Lemurinae		109°·25 (18)		,,
	Indrisinae		112°·2 (8)		,,
	Galaginae		114°·1 (6)		,,
	Chiromyrdae		117°·0 (2)		,,
	Lorisinae		122°·7 (6)		,,
Cebidae	*Mycetes*		115°·0 (2)	Mean 121°·17	Pearson and Bell
	Lagothrix		118°·0 (2)		,,
	Hapalinae		118°·5 (16)		,,
	Nyctipithecinae		120°·0 (8)		,,
	Pithecia		120°·5 (2)		,,
	Cebus		121°·0 (6)		,,
	Ateles		125°·9 (4)		,,
	Brachyurus		130°·5 (2)		,,
Simiadae	*Cercopithecus*		112°·3 (8)	Mean 116°·31	Pearson and Bell
	Cynocephalus		116°·4 (8)		,,
	Semnopithecus		116°·95 (10)		,,
	Cercocebus		117°·5 (4)		,,
	Macacus		118°·4 (14)		,,
Simiinae	Orang-utan		137°·2 (10)		Various
	Chimpanzee		127°·1 (35)		,,
	Gibbon		123°·9 (24)		,,
	Gorilla		119°·8 (62)		,,
	Dryopithecus rhenanus		125°·5 (1)		Cast

Race	Value ♂	Value ♂ + ♀	Value ♀	Source
Pithecanthropus erectus ...		124°·0 (1)		Dubois
Galley Hill		126°·0 (1)	Neanderthal (6) 115°·0	Cast
Neanderthal		123°·5 (1)		,,
Homo aurignacensis (*Hauseri*)		[120°] (1)		Photographs
Homo mousteriensis (*Hauseri*)		112°·5 (1)		Cast
Spy		112°·0 (1)		,,
La Chapelle-aux-Saints ...		112°·0 (1)		Photographs
Carlovingians		119°·0 (4)		Kuhff
Australians	119°·0 (5)		120°·0 (4)	Prochownick
17th century Londoners ("both faces") ...	120°·3 (456)		120°·5 (349)	Present Memoir
Prehistoric Paltacalo Indians	121°·1 (63)		121°·4 (49)	Antony and Rivet
Gallo-Romans		122°·0 (6)		Kuhff
Dolmens of the Lozère ...		122°·0 (5)		,,
Caroline Islanders	122°·1 (5)		122°·5 (4)	Prochownick
Fuegians		123°·0 (5)		Martin
Fuegians		123°·5 (10)		Hultkrantz
Viti Islanders	123°·6 (24)		117°·9 (7)	Prochownick
Modern French (Paris ?) ...	124°·05 (25)		124°·07 (14)	Bertaux
Prehistoric Indians of Equatorial and South America		124°·2 (452)		Rodriguez
Modern French (Paris ?) ...	124°·2 (61)		128°·4 (60)	Evangeli-Tramond
Neolithic French from Montigny ...	124°·2 (20)		128°·8 (4)	Manouvrier and Antony
Fuegians		124°·3 (12)		Rodriguez
Neolithic Swiss Dwarfs ...		124°·0 (4)		Schwerz
Chinese		124°·2 (6)		Rodriguez
Naqada Egyptians ("both faces") ...	124°·3 (45)		126°·8 (88)	Warren

Race	Value ♂	Value ♂ + ♀	Value ♀	Source
Berbers and Guanches ...		124°·6 (94)		Rodriguez
Ainos		124°·8 (8)		,,
Turks		124°·8 (18)		,,
Phoenicians and Carthaginians ...		124°·8 (16)		,,
Neolithic French (Caverne de l'homme mort)		125°·0 (8)		Kuhff
Laplanders		125°·0 (6)		Rodriguez
Modern English	125°·0 (15)		127°·0 (15)	Walmsley
Bajuvars, Swabians and Alemanns from Row Graves ...	125°·3 (45)		127°·2 (17)	Lehmann-Nitsche
Modern French		125°·8 (69)		Rodriguez
Modern French	125°·8 (169)		125°·8 (69)	Various
Canary Islanders		125°·9 (287)		Rodriguez
Merovingians		125°·9 (40)		,,
Neolithic Man (France) ...	126°·4 (53)		128°·2 (8)	Various
Rothwell English	126°·2 (183)		125°·4 (187)	Parsons
Swiss Alemanns	126°·3 (c. 163)		126°·5 (c. 163)	Schwerz
Neolithic Man (Brazil) ...	126°·4 (10)		126°·5 (7)	Manouvrier and Antony
Ancient Slavs		126°·5 (43)		Rodriguez
Neolithic Swiss (Chamblands)	126°·7 (17)		129°·1 (11)	Schenk
Basques		126°·7 (35)		Rodriguez
Modern Portuguese ...	126°·8 (134)		125°·1 (126)	Tamagnini and de Campos
Modern Viennese		126°·9 (100) (? ♂)		Mikulicz
17th century Londoners ("anterior face") ...	126°·9 (456)		125°·8 (349)	Pearson and Bell
Modern French	127°·0 (c. 25)		128°·0 (c. 25)	Charpy
Negroes (various localities)		127°·1 (97)		Rodriguez
Modern Bavarians	127°·2 (179)		126°·4 (29)	Bumüller
Modern "Germans" ...		127°·2 (18)		Rodriguez
Gauls and Romano-Gauls ...		127°·3 (78)		Rodriguez
"Ancient Egyptians" ...		127°·3 (22)		,,
Mediaeval French		127°·6 (183)		,,
Indo-Chinese		127°·7 (16)		,,
Polynesians		127°·6 (18)		,,
Franks and Burgundians ...		128°·0 (30)		,,
Men of Bronze Age (France)		128°·0 (46)		,,
Neolithic Man (France) ...		128°·2 (240)		,,
Japanese		128°·2 (92)		,,
Modern Bolognese	128°·5 (20)		126°·3 (23)	Zanolli
Neolithic Man (Châlons-sur-Marne) ...	128°·5 (23)		128°·2 (8)	Manouvrier
Eskimo		128°·7 (13)		Rodriguez
Neolithic Man, France (Baye) ...		129°·0 (19)		Kuhff
Malays		129°·0 (18)		Rodriguez
Patagonians		129°·0 (101)		,,
Indonesians		129°·5 (4)		,,
Modern Germans		130°·0 (??)		Langer
Veddahs		130°·0 (2)		Rodriguez
Australians		130°·0 (– ?)		Lustig
Hindoos		130°·2 (8)		Rodriguez
Maori		130°·4 (5)		Mollison
Naqada Prehistoric Egyptians ...	130°·9 (45)		133°·4 (88)	Warren, corrected to "anterior face" only
17th century Londoners (projection method) ...	130°·9 (456)		129°·8 (349)	Present Memoir
Modern French	131°·0 (c. 12)		129°·0 (c. 12)	Rodet
Melanesians		132°·0 (80)		Rodriguez
Negritos		132°·6 (42)		,,
Modern Swiss		133°·0 (– ?)		Martin
Ancient Persians from Anau		135°·3 (3)		Mollison

The reader is especially cautioned that at least three different methods (all illustrated on the 17th century Londoners) have been used by different investigators, and that this largely accounts for eccentricities in the serial order. The appearance of modern Europeans in the lower end of the table is probably due entirely to the use of the more correct projection method.

(vii) The Negro of Africa differs, however, from the Melanesians and Negritos, who have the most extreme collar angle hitherto recorded[1].

What is chiefly needed at the present time is a remeasurement of several sets of Rodriguez's series by the projection method in order to determine what correction is needful for comparative purposes.

We now turn to other features of the collar angle. Hirsch[2] without a really adequate amount of data has asserted that there is a relation between the size of the collar angle and (i) the shape of the cross-section of the neck, and (ii) the shape of the cross-section of the shaft in the subtrochanteric region. We have tested this by correlating the collar angle in our 17th century Londoners with (i) the primary index of the neck, and (ii) the platymeric index. We found the following values:

Correlation Coefficient	♂		♀	
	R.	L.	R.	L.
Collar Angle and Index of Neck ...	(221) + ·016 ± ·045	(227) + ·098 ± ·044	(157) + ·248 ± ·051	(180) + ·319 ± ·045
Collar Angle and Platymeric Index	(230) + ·422 ± ·037	(231) + ·310 ± ·040	(164) + ·259 ± ·049	(183) + ·456 ± ·039

The numbers in brackets are those of the population dealt with.

It will be seen that the collar angle is sensibly related to the shape of the shaft at the platymeric section—the rounder the shaft or the less the platymery the greater the collar angle. This probably only means that a low collar angle in man, involving the neck springing more horizontally from the shaft, increases the subtrochanteric transverse diameter and so reduces the platymeric index, *i.e.* increases the platymery.

In the case of the female there is a small but quite sensible correlation between a high collar angle and a high neck index. The relationship is hardly sensible for males, but as it is in both cases of the same sign as the females, we may assume it to exist in the male, although in reduced intensity. A high neck index means a relatively small diameter for the neck in the vertical plane, and consequently less resistance to bending moment. But with a high collar angle there will be greater thrust and less bending moment for the same body weight. Thus mechanically the relationship might be justified as an economical use of the available material.

The point if a small one seemed worth pursuing further; in particular because a study of the anterior and posterior flattening of the femur in the trochanteric region in a long series of primates had convinced us that the platymeric index taken in the *subtrochanteric* region was a very partial measure of this flattening. Accordingly the correlations between the collar angle and both platymeric index and ellipticity of the neck were determined for 80 species of primates; these included eight races of man covering recent and primogenial types, *Pithecanthropus erectus*, two fossil apes, five species of Anthropoids, 23 species of Old World apes, 20 species of New World apes and 22 Lemuroids. The following results were reached:

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[1] The place as already stated of our 17th century Londoners, and of Martin, Mollison and Rodet's results, is probably due to the use of a projection method.

[2] Bibl. 82, S. 678—9.

Interspecial Constants for Primates.

	Collar Angle	Platymeric Index	Ellipticity of Neck
Mean	117°·59	... 91·06	... 73·92
Standard deviation	7°·96	... 9·929	... 8·265

Correlation Coefficient of Collar Angle and Platymeric Index − ·1701 ± ·0518
" " " " Ellipticity of Neck + ·2403 ± ·0512

These results are of interest; the correlations are small but sensible. They indicate that throughout the primates there exists a small relationship between the shape and slope of the neck, the greater the angle the neck makes with the *vertical* the greater the ellipticity of the neck, *i.e.* the vertical diameter of the neck increases relatively to the horizontal diameter as the neck becomes more horizontal. On the other hand the interspecial correlation of collar angle and platymeric index does not confirm the intraspecial value as found for one race of man,—but is of negative sign,—a high collar angle being associated with a low platymeric index. In fact the high collar angles occur usually in Man and the Anthropoids, and occasionally in certain South American monkeys (*e.g. Cebus, Chrysothrix,* and *Callithrix*), and in certain Lemuroids (*e.g. Potto* and *Loris gracilis*), but in all these cases there is considerable platymery, while where the platymery is low or the platymeric index high, as in the *Semnopithecidae* and *Cercopithecidae*, the collar angle is relatively low. Even with the few Lemuroids (*e.g. Galago crassicaudatus* and *Chirogaleus*) where a high platymeric index may be reached the collar angle is below the primate mean. Thus with the primates as a whole a rounded shaft in the subtrochanteric region is slightly associated with a horizontally tending neck—the reverse of what we find in the case of the human femur.

A point which lies somewhat aside from our present topic, but which the reader may pardon if thrown out merely as a suggestion at this stage of our investigation, is this: The mean of the primate constants, if we suppose evolution to have spread out the members of this group in a fairly balanced manner, may roughly suggest the direction in which we might search for the primitive primate type. The following constants are interesting from this standpoint:

	Collar Angle	Platymeric Index	Ellipticity of Neck
*Homo sapiens** ...	127°·3	77·3	78·8
Mean of Primates ...	117°·6	91·1	73·9
Lagothrix	118° 0	94·3	76·9
Tarsius spectrum ...	109°·0	88·8	58·2

* Mean for a large number of races of Recent Man.

The values for *Lagothrix* are about as close to the primate values as any species we have come across, and in many respects its femur appears to us to be of a primitive type. It seems more reasonable to suggest that the higher primates have been evolved from some such form as *Lagothrix* on their way from the Lemuroids, rather than to link them up with *Tarsius* directly, which may after all be a side track[1]. Be this as it may the last word on the evolutionary history of the primates will not, we believe, have been spoken—especially from the osteological side—until we know the inter-special means and correlations for a number of characters of various parts of the primate skeleton.

(viii) INDICES OF THE NECK.

The two principal indices of the neck are (*a*) the Primary Index or Ellipticity of the Neck measured by 100 × the Ratio of the Minimum Horizontal Diameter to the Minimum Vertical Diameter of the Neck, and (*b*) the Secondary Index which is measured by 100 × Ratio of the Minimum Horizontal Diameter of the Neck to the Horizontal Diameter of the Head. Unfortunately we have not much data for either of these indices.

Bertaux uses as his Index of the Neck 100 × Vertical Diameter/Horizontal Diameter, *i.e.* the inverse of ours. Evangeli-Tramond also uses this inverse[2]. In the case of what we have called Bertaux's 1st Series, his *Série déterminée*, *i.e.* that in which sex, age and stature were known, we have inverted all his indices and taken their mean value. In this way we determined a correction to pass from the inverse of the mean to the mean of the inverses, and applied this correction to his other series, for which, however, we recalculated the means of his indices as we did not agree with them. It will be seen that thus modified his results for the French now agree closely with ours for the English. Our usual form of summary provides the following series for the Ellipticity of Neck:

Lemuroids	73·25
Cebidae	74·26
Simiadae	76·70
Greater Anthropoids	75·73
Recent Gibbon	80·5
Dryopithecus rhenanus	85·1
Neanderthal Type (6)	84·5 ?
Recent Man (mean 20 racial groups)	77·50
17th century Londoners	76·3

Now these results are somewhat noteworthy. The *Cebidae* rise slightly on the Lemuroids, but from the Lemuroids through the *Simiadae* to the Greater Anthropoids

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[1] F. Wood-Jones: *Arboreal Man*, London, 1916, and *The Problem of Man's Ancestry*, London, 1918.

[2] We regret not being able to use Evangeli-Tramond's results. We recalculated all the indices from his measurements as we had found inaccuracies and we thus obtained the results

♂ R. (30) 88·07 ♂ L. (7) 79·98 ♀ R. (30) 83·19 ♀ L. (30) 86·37

or ♂ (R. + L.) (37) 86·54 ♀ (R. + L.) (60) 84·72.

These values, presumably for French, are incomparable with anything else in our table. His manner of measurement, not defined, must have been wholly different.

TABLE XXXVII. *Table of Ellipticities of Femoral Neck.*

	Race	Ellipticity ♂ + ♀		Source of Data
Lemuroids	*Tarsiidae*	58·15 (2)	Mean 73·25	Pearson and Bell
	Galaginae	68·2 (6)		,,
	Lemurinae	70·5 (18)		,,
	Indrisinae	72·4 (8)		,,
	Chiromyrdae	79·75 (2)		,,
	Lorisinae	90·5 (6)		,,
Cebidae	*Hapalinae*	65·2 (16)	Mean 74·26	Pearson and Bell
	Nyctipithecinae	65·2 (8)		,,
	Pithecia	70·2 (2)		,,
	Brachyurus	72·5 (2)		,,
	Cebus	76·75 (6)		,,
	Lagothrix	76·85 (2)		,,
	Ateles	78·8 (4)		,,
	Mycetes	88·55 (2)		,,
Simiadae	*Cercopithecus*	72·0 (8)	Mean 76·70	Pearson and Bell
	Cynocephalus	74·5 (8)		,,
	Macacus	77·9 (14)		,,
	Semnopithecus	79·0 (10)		,,
	Cercocebus	80·1 (4)		,,
	Dryopithecus rhenanus ...	85·1 (1)		Cast
Simiinae	Gorilla	75·5 (21)	Mean 75·73	Various
	Chimpanzee	75·5 (11)		,,
	Orang-utan	76·2 (5)		,,
	Gibbon	80·5 (16)		,,

Race	Ellipticity ♂ + ♀	♂	♀		Source of Data
Pithecanthropus erectus ...	?				—
Homo mousteriensis (*Hauseri*)	97·9 (1)			Mean Neanderthal 84·5? (6)	Cast
Spy	82·0? (1)				—
Neanderthal...	73·6 (1)				Cast
Galley Hill	69·6? (1)				—
Homo aurignacensis (*Hauseri*)	74·2 (1)				—
Fuegians	83·28 (10)				Hultkrantz
Negroes	81·44 (34)				Bertaux
,, ...	80·15 (12)				Bumüller
Non-adult French	80·82 (17)				Bertaux
Paltacalo Indians		80·94 (63)	79·56 (52)		Antony and Rivet
Bolognese		79·8 (20)	79·6 (23)		Zanolli
Guanches	77·64 (48)				Bertaux
French (1st Series)		76·95 (29)	75·40 (17)		,,
French (2nd Series) ...	76·46 (42)				,,
17th century Londoners ...		75·69 (459)	76·92 (350)		Pearson and Bell
Bavarians	75·25 (32)				Bumüller
Dolmens of Lozère	74·00 (5)				Kuhff
Bajuvars from Row Graves		74·01 (24)	76·43 (9)		Lehmann-Nitsche
Swabians and Alemanns from Row Graves ...		72·37 (21)	73·30 (8)		,, ,,
Australians		65·8 (2)	74·25 (2)		Pearson and Bell

there is only a rise of 2 to 3 points in the *mean* values. If, however, we examine the genera in the individual families we find an extraordinary variation, so that the value of the index is almost a generic character. Femora of *Tarsius*, the Lemurs and the *Lorisinae* could be identified by this index alone; and the same is true of the *Hapalinae*, *Cebus* and *Mycetes*, or of *Cercopithecus* and *Cercocebus*. The ranges of the Lemuroids and *Cebidae* cover the whole range of Man, and that of the *Simiadae* at least the range of Recent Man. Even the Recent Gibbon which stands out so markedly from the nearly uniform values of the Greater Anthropoids finds its parallel in *Ateles* (78·8), and *Mycetes* exceeds *Dryopithecus rhenanus*. The high value of the latter suggests that the low value of the Greater Anthropoids may be a decline from a much higher value in their fossil ancestry. This would support the somewhat doubtful high value in Neanderthal Man, and give the protsimio-human a rotund rather than elliptic form of neck. Without this support from the Eppelsheim femur we should have been inclined to discredit the Neanderthal Type high value, and supposed *mean* values for the ellipticity of the neck to have remained fairly constant from *Simiadae* to Recent Man.

There is no very definite type for this character determinable for the Lemuroids, as our knowledge of the Aye-Aye is based solely on two femora. For the *Cebidae* the type lies between *Brachyurus*—only known to us by two femora of a young animal—and *Cebus*. *Macacus* is type for the *Simiadae*, and especially relying on our own measurements, the Chimpanzee for the Greater Anthropoids. Our value for the Chimpanzee is 77·3, in striking agreement with the mean of 20 racial groups of Recent Man, and emphasising again the troglodytic associations of the human femur.

Primogenial Man, as we have already remarked, appears to be somewhat inconclusive. Of the very doubtful Galley Hill value nothing can be said. The Neanderthal femur itself gives a result which is also surprisingly low, but the remaining femora of Neanderthal Type provide such high indices that the average of six is surprisingly high! Hence it is only probable, we cannot say certain, that the Greater Anthropoids are separated by Recent Man from Primogenial Man. Unfortunately we have no data for the Cromagnon Type. As far as our material allows us to judge it would seem that in the ellipticity of the neck the human series runs from the high value of Primogenial Man down to the low value of the Greater Anthropoids, starting with the more primitive races such as Fuegians, Negroes and Indians and concluding with Modern Europeans and their forbears. In this as in several other cases Modern Europeans appear to be nearer to the apes than primitive races. This conclusion is to some extent confirmed by Bertaux's small series of non-adult French, which has a mean approaching that of the Negroes. Probably the flattening of the neck in the ape and in Modern Man arises from different causes, the one flattening can hardly be regarded as a reversion to the other. Still the repeated occurrence of this scission of the primates deserves very careful inquiry.

If we have a paucity of material for the ellipticity of the neck we have still less for the secondary index which compares the size of the head with that of the neck. A good deal more would have been available, if the writers of the French

School had published their absolute values as well as their indices. We have in the usual form:

Lemuroids	58·77
Cebidae	53·64
Simiadae	60·36
Dryopithecus rhenanus ...	59·8
Simiinae	49·12
Neanderthal Type (6) ...	60·2
17th century Londoners ...	55·38

The interpretation of these results is not very easy. The tendency seems to be increase of horizontal diameter of head relative to horizontal diameter of neck. This is exhibited in the *Cebidae* and *Simiinae*, but the intermediate link to the *Simiinae*, the *Simiadae*, in this exceptional case shows a rise, which is surprising. As usual Neanderthal Type shows the reversed tendency, supported in this case as in the last by *Dryopithecus rhenanus*, although the Recent Gibbon exhibits the *Simiinae* fall and is in fact the type anthropoid for this character[1]. Recent Man regresses, as we are accustomed to see, from the Neanderthal Type to a more simian character.

TABLE XXXVIII. *Table of Secondary Index of the Neck* (*i.e.* 100 × Minimum Horizontal Diameter of Neck / Horizontal Diameter of Head).

	Race	Secondary Index of Neck	
Lemuroids	*Tarsiidae*	53·75 (2)	Mean 58·77
	Chiromyrdae ...	56·75 (2)	
	Indrisinae	58·1 (8)	
	Lemurinae	58·6 (18)	
	Galaginae	60·8 (6)	
	Lorisinae	64·6 (6)	
Cebidae	*Pithecia*	47·85 (2)	Mean 53·64
	Brachyurus ...	50·45 (2)	
	Hapalinae	51·6 (16)	
	Nyctipithecinae ...	52·0 (8)	
	Ateles	52·9 (4)	
	Cebus	54·9 (6)	
	Lagothrix	58·95 (2)	
	Mycetes	60·45 (2)	
Simiadae	*Cynocephalus* ...	54·1 (8)	Mean 60·36
	Cercopithecus ...	58·4 (8)	
	Macacus	60·8 (14)	
	Semnopithecus ...	62·6 (10)	
	Cercocebus	65·9 (4)	
	Dryopithecus rhenanus ...	59·8 (1)	
Simiinae	Gorilla	54·83 (7)	
	Gibbon	49·95 (2)	
	Chimpanzee	48·5 (2)	
	Orang-utan...	43·2 (5)	
	Homo mousteriensis (*Hauseri*)	68·6 (1)	
	Spy	58·9 (1)*	
	Neanderthal	53·2 (1)	
	Galley Hill	50·0? (1)	
	Homo aurignacensis (*Hauseri*)	53·5 (1)	
		♂ ♀	
	17th century Londoners ...	55·23 (370) 55·54 (280)	
	French Neolithics (calculated on the basis of Manouvrier and Antony's Montigny material)	53·46 (23)	
	Australians	50·4 (2) 47·85 (2)	

* This is the value obtained by us from the cast. Fraipont and Lohert's measurements provide Spy No. 1: 59·3, Spy No. 2: 64·2, which confirm the view that a high value must be given to the Secondary Index of the neck in Primogenial Man of Type A.

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[1] The other types are Lemur proper for the Lemuroids; *Ateles* or *Cebus* for the *Cebidae*, and *Macacus* for the *Simiadae*.

(ix) THE LEMOTIC INDEX.

Of the absolute measurements of the neck we have said nothing so far, chiefly because authorities by no means agree as to the manner in which the neck should be determined. Further growth in absolute size from Lemuroids through lesser apes to man is obvious and has been sufficiently demonstrated over other characters, if any demonstration were needful. All the cases known to us of Primogenial Man including Galley Hill and *Homo aurignacensis* (*Hauseri*) have short necks—the sole exception being the La Chapelle-aux-Saints femur. *Pithecanthropus erectus* is well within the modern range. If we wish to draw conclusions from *relative* length of neck we may take the ratio of length of neck to oblique length, although at first sight it seems likely that the Secondary Bust Index already discussed contains all the information likely to be obtained in this manner. We find the following results:

TABLE XXXIX. *Table of Index* (100×Length of Neck/Oblique Length of Femur).

	Race	Lemotic* Index	
Lemuroids	*Tarsiidae*	4·75 (2)	Mean 6·23
	Chiromyrdae	5·7 (2)	
	Galaginae	6·2 (6)	
	Lorisinae	6·4 (6)	
	Indrisinae	7·1 (8)	
	Lemurinae	7·25 (18)	
Cebidae	*Hapalinae*	6·6 (16)	Mean 8·56
	Nyctipithecinae ...	6·8 (8)	
	Brachyurus	7·3 (2)	
	Pithecia	7·95 (2)	
	Cebus	8·35 (6)	
	Mycetes	9·8 (2)	
	Ateles	10·8 (4)	
	Lagothrix	10·9 (2)	
Simiadae	*Semnopithecus* ...	7·4 (10)	Mean 8·25
	Cercopithecus ...	7·6 (8)	
	Cercocebus	8·1 (4)	
	Macacus	8·8 (14)	
	Cynocephalus	9·35 (8)	
	Dryopithecus rhenanus	10·8 (1)	

	Race	Lemotic Index	
Simiinae	Gorilla (i)	15·87 (7)	
	,, (ii)	[16·43 (14)]	
	Chimpanzee (i)	14·20 (2)	
	,, (ii) ...	[13·26 (10)]	
	Orang-utan	14·40 (5)	
	Gibbon	9·55 (2)	
	Pithecanthropus erectus	11·39 (1)	
	La Chapelle-aux-Saints ...	13·22 (1)	11·10 (4)
	Homo mousteriensis (*Hauseri*)	11·46 (1)	
	Spy	11·27 (1)	
	Neanderthal	8·45 (1)	
	Galley Hill	11·25 (1)	
	Homo aurignacensis (*Hauseri*)	11·47 (1)	
	Cromagnon Type	11·1 (5)	
	Grimaldi Type	12 6 (2)	
		♂	♀
	17th century Londoners ...	12·64 (456)	11·68 (349)
	Modern French	[13·01 (29)	12·56 (17)]
	Australians	12·75 (2)	9·35 (2)

* Greek, λαιμός, the neck. It will be convenient to have a name for this index.

The values in square brackets are deduced from Bertaux's measurements by finding a single reducing factor giving the greatest accordance for the four series; it is 1·24. Bertaux[1] measures the true neck and not the bust. Parsons[2] and Tamagnini with de Campos[1] have measured the bust but called it the neck, which is misleading. Subtracting half the diameter of the head from their "neck" values and using the same reducing factor as we have found from Bertaux's results, we reach the following values:

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[1] Bibl. 52, p. 220. His values for length of neck are ♂ 47·11, ♀ 40·92; probably he measures from base of head to trochanteric line.

[2] The results in Parsons' case again emphasise the evil of sexing by selection of small heads or busts, the female lemotic index being suspiciously low. Evangeli-Tramond also gives values for length of "neck," but we have been quite unable to associate his values with anything like the bust less radius of head. They are much too *large* for this. Thus we find from his data ♂ L. 91·65, ♂ R. 86·70, ♀ L. 72·35, ♀ R. 76·60. These values for length of neck vastly exceed any values for the whole length of bust with which we are acquainted. (See Bibl. 65, pp. 82—5.) They approach the entire proximal breadth.

Lemotic Index	Portuguese	♂ 11·58 (134), ♀ 11·28 (126)
	Rothwell English	♂ 11·22 (178), ♀ 10·49 (105).

It is fairly clear that our factor does not fully compensate for the individual method of measuring the "neck" adopted by these authors, and indeed we have no reason for supposing that Parsons and Tamagnini with de Campos adopted the same method as Bertaux, rather the reverse[2].

We may draw, however, one important result from the 17th century Londoners, the Rothwell English, the modern French and the modern Portuguese—*the neck relative to the absolute size of the femur is smaller in woman than in man.* In Portuguese, Rothwell English and 17th century Londoners the smaller value of the collar angle of the female is far from adequate to produce a visible hip extension in the female compared with the male. For a short series of modern French there is a like smaller value in the female collar angle. Walmsley for another very short series gives an excess of collar angle even in the female, while a long modern French series gives absolute equality in the two sexes[3]. We are thus compelled to accept Charpy's conclusion that relatively larger haunches in the female are not due to the fact that she has a relatively larger femoral neck or a markedly smaller collar angle[4], but arise from her having a relatively broader pelvis.

Summarising in the usual form we have for the Lemotic Index of our families of primates:

Lemuroids	6·23	(Type *Galaginae*)
Cebidae	8·56	(Type *Cebus*)
Simiadae	8·25	(Type *Cercocebus*)
Greater Anthropoids	14·76[5]	(Type Orang)
Neanderthal Type (6)	11·3	
Recent Man (46 racial groups) ...	11·52	
17th century Londoners	12·16	

Alongside these we may put for comparison

Dryopithecus rhenanus	10·8
Recent Gibbon	9·55
Ateles	10·8

indicating again the close resemblance of the femur of *Ateles* to that of the Gibbon.

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[1] Bibl. 118.

[2] See footnotes 1 and 2 on previous page.

[3] Bertaux, Bibl. 118.

[4] Charpy for a moderate amount only of material finds ♂ 127°, ♀ 128° for collar angle. But he asserts the existence of two human types and gives 1st Type Mean ♂ = Mean ♀ = 131° and 2nd Type Mean ♂ = Mean ♀ = 122°. Bibl. 36, p. 287 *et seq.*

[5] If we include Recent Gibbon, we have for the *Simiinae* 13·46 which makes the Chimpanzee rather than the Orang the type.

Generally we see great development of the neck relative to the size of the femur from *Tarsius* at 4·75 to Man at 12·2. But here the Greater Anthropoids have outrun even Neanderthal Man, who was in this feature close to the average of Recent Man. We should expect the protsimio-human femur to have a Lemotic Index from 11·5 to 12·2 standing not far from midway between fossil Gibbon 10·8 and Chimpanzee 13·5. We long again to test this result on a fossil Chimpanzee-like femur.

Our table further confirms a conclusion of Rodriguez who, starting with a very different outlook from ourselves, we have yet found a very reliable observer. This conclusion is that the Anthropoids with the exception of the Gibbon have a relatively long femoral neck[1]. Our data suffice to show that Modern Man again separates Primogenial Man from the Anthropoids (excluding the Gibbon). The Galley Hill femur is closer to the average Neanderthal Type than to Modern Man and this appears probable of *Homo aurignacensis* (*Hauseri*). If our value for *Pithecanthropus erectus* be correct the Trinil femur is in this solitary feature closer to Primogenial than to Modern Man, although still within the possible human especially female range, and *à fortiori* further removed from the Greater Anthropoids. We have not adequate material for the determination of the mean Lemotic Index for the Gibbon, but our two cases here as in many other characters do not lend help to Bumüller's view that the Trinil femur is that of a giant Gibbon.

In our table on p. 361 we have given the conventional length of neck, *i.e.* capito-collar axis less radius of head, as deduced by a series of fairly reasonable hypotheses from Rodriguez's data. If we divide these neck lengths by the oblique lengths as given by Rodriguez, we obtain the Lemotic Indices for a number of races. The values for ♂ and ♀ will necessarily be the same owing to the nature of the hypotheses; this conclusion as we have seen is only roughly correct. We have therefore not ventured to place these somewhat hypothetical results in the previous table. While the present table as far as the Europeans are concerned is fairly self-consistent it differs not a little from the other, *i.e.* the diversity of method leads to sensibly diverging results for the same race. It is clear from this table that Negroes, Australasians and the bulk of Asiatics—Japanese and Ainos excluded—have a relatively short femoral neck. These races are hypobrachy-lemotic (below 10·9); the brachy-lemotic (10·9—11·4) are American Indians—some ancient equatorial Indians excluded—the Ancient Egyptians, and the Guanches, closely associated in this as in some other femoral characters with the Cromagnon Type.

In the meso-lemotic group (11·4—11·9) we find besides the Japanese and Aino, the neolithic Bronze Age men and some of the historic forbears of modern Europeans. Modern Europeans and their forbears form the bulk of the dolicho-lemotic group (11·9—12·3), while the hyperdolicho-lemotic (over 12·3) races are the ancient equatorial Indians and probably such primitive peoples as Basques, Maori and Laplanders, our "fringe" races. The table is not without suggestiveness, but it needs substantiating and developing, especially in the direction of differentiating the sexes. This can only be done when a standardised measurement of the neck has been established. But after due consideration we consider the present Lemotic Index has in several respects distinct advantages over the Bust Ratio.

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[1] Bibl. 101, p. 39.

TABLE XL. *Table of the Lemotic Index, based chiefly on deductions from Rodriguez's material.*

Race	Lemotic Index	Race	Lemotic Index
Laplanders	13·0 (6)	Cromagnon	11·5 (13)
Ancient Equatorial Indians ...	12·8 (126)	Negroes (? *locus*)	11·5 (48)
Ancient Bolivians	12·3 (51)	Turks	11·5 (18)
Maori	12·2 (6)	Canary Islanders	11·5 (287)
Basques	12·2 (35)	Berbers and Guanches	11·4 (94)
17th century Londoners	12·2 (805)	Ancient Egyptians	11·4 (22)
Modern French	12·1 (69)	Ancient Venezuelians	11·4 (43)
Modern Germans	12·1 (18)	Patagonians	11·3 (101)
Mediterranean Race (Old and New)	12·0 (32)	Ancient Mexicans	11·3 (22)
Mediaeval French	11·9 (183)	Californian Indians	11·3 (122)
Modern Portuguese	11·9 (260)	Indo-Chinese	11·3 (16)
Veddahs	11·9 (2)	Hindoos	11·1 (18)
Eskimo	11·9 (13)	Polynesians	10·9 (18)
Japanese	11·9 (92)	Phoenicians and Carthaginians ...	10·9 (16)
Ainos	11·8 (8)	Chinese	10·9 (6)
Gauls and Romano-Gauls	11·8 (78)	Neolithic Swiss Dwarfs	10·9 (4)
Ancient Slavs	11·7 (43)	Mozambique Negroes	10·9 (13)
Neolithic Europeans	11·7 (240)	New Guinea Negroes	10·8 (16)
Fuegians	11·7 (12)	Congolese	10·7 (20)
Peruvian Indians	11·7 (75)	Indonesians	10·6 (14)
Bronze Age Europeans	11·6 (46)	Melanesians	10·5 (80)
Franks and Burgundians	11·5 (30)	Malays	10·5 (118)
Merovingians	11·5 (40)	Negritos	10·5 (42)

Recently Walmsley[1] has taken up the problem of the relative size of the neck and formed the Lemotic Index for 30 adults, nine non-adults and one foetus. His definition both of capito-collar axis and of axis of shaft is not in agreement with ours and we believe too vague[2]. However he appears from his figures to be dealing with a measurement on the anterior face of the femur, and we have applied to his numbers the same factor as we obtained from Bertaux's results, so that we can roughly compare them with our own. We reach the following results:

	Lemotic Index
Foetus 5 months	5·7
Birth	5·3
Non-adult 2 years	6·5
,, 4 ,, ...	7·6
,, 5 ,, ...	7·9
,, 8 ,, ...	8·3
,, 10 ,, ...	9·7
,, 14 ,, ...	11·4
,, 16 ,, ...	11·9
,, 18 ,, ...	11·9

Adult ♂ 12·03 (15) Adult ♀ 12·65 (15)

[1] Bibl. 113, p. 322 *et seq.*

[2] Thus the axis of neck is said to be line bisecting "base line of head" and "lying in the centre of the neck"—whatever that point may be. The axis of the shaft is defined as "extending through the centre of the bone" and it "if prolonged downwards would bisect the intercondylar line at the lower end of femur" (Bibl. 113, p. 321). We do not know what point is the "centre of the bone," or what is "the intercondylar line," although the wording suggests that the latter is unnecessary, as the axis would only bisect it *if* produced.

The adult values are fairly close, considering the differences of methods of measurement used, to those we have given for modern French and 17th century Londoners. On the other hand Walmsley gives a somewhat greater lemotic index for females than for males. Bertaux using two more females and nearly double as many males also indefinitely sexed, *i.e.* dissecting room material, found the exact opposite and all the long series of femora sexed by anatomical appreciation agree in this judgment. We cannot therefore hold Walmsley's slender material to upset this conclusion. Nor are we forced to do so, for a rough estimate gives the standard deviation of this index as about 1·2, leading in a mean based on 15 cases to a probable error of ·31, and accordingly in the case of the difference of two sets of 15 to a probable error of ·44. Thus the difference observed by Walmsley is less than 1·5 times its probable error and is not *significant*. It is another illustration of the danger of short series.

Walmsley's observations of the steady increase of the lemotic index with growth stand on a stronger basis because they are continuously in one sense. They show, however, that the stages of non-adult growth are far from indicating any evolutionary history approximating man to the Greater Anthropoids. They might well represent a Lemuroid to lesser ape evolution.

It would be of some interest to compare the changes in the lemotic index of the Anthropoids during the non-adult period. Neither our result nor Walmsley's suggests —what has been asserted by some anthropologists—that woman is more apelike than man; and our results do not show that woman in this character is *markedly* more "infantile" than man—and *à fortiori* Walmsley's do not; the hypothesis of female infantilism is another of the largely unproven hypotheses of the older anthropological school.

(x) The Epiphysial Ratio and Capito-bicondylar Index.

The remaining characters which we propose to deal with in this section, the Epiphysial Ratio and the Capito-bicondylar Index already discussed on pp. 348—9, link together the proximal and distal epiphyses. Having discarded the proximal breadth as of too uncertain a character to be of fundamental service, we considered the Capito-collar Axis or length of the bust to be the best representative of the magnitude of the proximal epiphysis, and its ratio to the Bicondylar Width the most satisfactory index by which to measure the relative magnitude of the proximal and distal epiphyses. Unluckily our material is limited in two ways. First because an accurately defined bust length has rarely been included among the hitherto published femoral measurements and secondly because one or two recent writers who have had fairly long series to study have dropped the old established Bicondylar Width and replaced it by a new measurement, *i.e.* that of the distal articular surface. Unfortunately Rodriguez who has clearly measured the length of bust[1] as we have done, or very closely as we have done, has published no measurements at all on the distal epiphysis. Hence for this epiphysis we lose his aid which has so often been of service in helping out the otherwise scant supply of comparative material. Hepburn gives the Bicondylar Width of a number of races, but not the length of bust. We have ventured to combine for a few races Hepburn's value of the Bicondylar Width with Rodriguez's value of the bust length, but these results must be viewed with great suspicion, not only on account of the fact that the measurements have been made on different groups of individuals, but also because they depend in many cases on a few isolated bones. They are in the following table indicated by square brackets. The first of the accompanying numbers in the round brackets signifies the number of cases for the Bicondylar Width, the second that for the bust length. Both sexes are in these instances combined as Rodriguez gives us no means of distinguishing between the two. This adds to the doubtful character of these tabled values, as although the indices may be the same for the two sexes, we have had to deduce absolute values before we could proceed to a new index, and we could only do this on the assumption of equality

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[1] Rodriguez does not give the bust length, but he does give the Oblique Length and Secondary Bust Ratio, so that something like the bust length can be computed from what he does give: see our pp. 350, 361—3.

TABLE XLI. *Table of Epiphysial Ratio.*

	Race	Epiphysial Ratio	
Lemuroids	*Chiromyrdae*	65·9 (2)	Mean 75·86
	Tarsiidae	70·25 (2)	
	Galaginae	70·4 (6)	
	Lorisinae	71·3 (6)	
	Lemurinae	86·4 (18)	
	Indrisinae	90·9 (8)	
Cebidae	*Nyctipithecinae* ...	72·8 (8)	Mean 83·21
	Hapalinae	73·4 (16)	
	Cebus	80·3 (6)	
	Lagothrix	80·85 (2)	
	Mycetes	84·25 (2)	
	Pithecia	85·05 (2)	
	Brachyurus	86·9 (2)	
	Ateles	102·1 (4)	
Simiadae	*Cercopithecus*	76·25 (8)	Mean 82·90
	Semnopithecus ...	80·5 (10)	
	Macacus	81·6 (14)	
	Cynocephalus	87·3 (8)	
	Cercocebus	88·85 (4)	
	Dryopithecus rhenanus	105·6 (1)	
Simiinae	Gibbon	103·05 (2)	
	Gorilla	91·7 (7)	Mean 93·10
	Chimpanzee	90·0 (2)	
	Orang-utan	97·6 (5)	

Race	Epiphysial Ratio	
Pithecanthropus erectus ...	94·9 (1)	
La Chapelle-aux-Saints ...	98·2? (1)	Mean Neanderthal (6) 83·0
Homo aurignacensis (*Hauseri*)	92·0 (1)	
Galley Hill	82·0?? (1)	
Spy	81·4 (1)	
Homo mousteriensis (*Hauseri*)	80·4 (1)	
Neanderthal	72·0 (1)	
Laplanders	[106·9 (4 + 6)]*	
Australians	101·65 (2) 83·6 (2)	
Fuegians	[97·9 (5 + 12)]†	
Maori‡	97·7 (5)	
17th century Londoners ...	96·88 (306) 96·22 (201)	
Guanches	[95·4 (2 + 94)]*	
Eskimos	[95·4 (4 + 13)]*	
Veddahs	[95·3 (2 + ?)]§	
Negritos	[93·4 (42 + ?)]§	
Negroes	[90·7 (9 + 48)]*	
Japanese, 1st Series ...	[87·8 (92 + ?)]§	
Hindoos	[86·9 (6 + 18)]*	
Japanese‖, 2nd Series ...	86·5 (20) 86·7 (20)	
Ainos‖	86·4 (40) 86·7 (22)	
Chinese	[83·9 (2 + 6)]*	
Malays	[82·4 (118 + ?)]§	

* Deduced from combining material of Rodriguez and Hepburn.

† Deduced from combining material of Rodriguez and Martin.

‡ Mollison.

§ Deduced from combining material of Rodriguez and Mollison.

‖ Koganei, but his capito-collar axis differs somewhat from ours. The measurements, however, accord with those of the 1st Series of Japanese.

in the two sexes, which may possibly be approximately true in Rodriguez's cases, but is not true in Hepburn's.

Summary of results for Epiphysial Ratio of the primate families:

Lemuroids	75·86	(Type *Lorisinae*)
Cebidae	83·21	(Type *Pithecia*)
Simiadae	82·90	(Type *Macacus*)
Greater Anthropoids	93·10	(Type Gorilla)
Neanderthal Type (6)	83·0	
[Galley Hill	82·0 ? ?]	
Cromagnon Type (5)	92·3	
Grimaldi Type (2)	94·5	
[Recent Man (18 racial groups)	91·84]	
17th century Londoners	96·55	

It will thus be seen that from the Lemuroids upwards the tendency has been for increase of the proximal relative to the distal epiphysis. The Gibbons are side tracked in their exaggerated value, although the slender data for Laplanders and Australians show like human values:

Dryopithecus rhenanus	105·6
Recent Gibbon	103·05
Ateles	102·1

Ateles as usual following the Gibbon and diverging widely from all the other *Cebidae*. The ascent is very marked up to the Greater Anthropoids. Then comes a reversion to the *Simiadae* level with man of the Neanderthal Type, but the increase again goes on through Cromagnon and Grimaldi up to our 17th century Londoners.

The value of the Epiphysial Ratio for the La Chapelle-aux-Saints femur is disturbing, but that value is itself doubtful. We are inclined to hold, however, that Primogenial Man of the Neanderthal Type had compared with Modern Man a proximal epiphysis small as compared to the distal. Thus Recent Man has again relative to Neanderthal Man reverted to more anthropoid proportions. The more than doubtful Galley Hill result associates this femur more closely with the Neanderthal Type than with Modern Man, and if it had been reliable would have differentiated it from *Homo aurignacensis* (*Hauseri*) which falls into the Modern Man range. *Pithecanthropus erectus* is absolutely human, and, despite Bumüller's judgment, is differentiated from our specimens of the Gibbon more than from any other ape. Of the range of Modern Man it is impossible to say much, but the order suggested—far indeed from established by such data—is: certain "fringe" folk, modern Europeans, Negroes, Asiatics, the latter being closest to the Neanderthal Primogenial Type.

A less satisfactory measure of the relative proportions of the two epiphyses may be obtained from the Capito-bicondylar Index. Here again we are met by the same difficulty—osteologists seem to have a preference for either proximal or distal epiphysis and rarely provide adequate measures of both. A table of the Capito-bicondylar Index has been given in Table XXX, p. 348, of this paper. It will be seen on examining that table that the conclusions to be drawn are not identical with those from the table of the Epiphysial Ratio. The proportion of femoral head to bicondylar width is clearly not the same as that of neck to bicondylar width. The proportions in which neck and head divide the bust vary widely in the various races. Modern Man in Capito-bicondylar Index dichotomises the ape series. The Neanderthal Type has a high proportion of head to bicondylar width but probably a low proportion of bust to bicondylar width. In the former it exceeds the Anthropoids and Recent Man, in the latter it falls short of them. Fuegians and Maori stand high in the Epiphysial Ratio and low in the Capito-bicondylar Ratio. It is possible that a compensatory principle exists and that a large development of the head takes place at the cost of the neck. At any rate the evolutions of head and neck have not been proportional. But more material must be available before any really safe conclusions can be formed. Both Epiphysial Ratio and Capito-bicondylar Index are probably of value, but the former, judging merely from our present slender data, seems likely to prove more suggestive.

(xi) *Concluding Remarks.* As in the case of the General Indices and the Special Indices of the Shaft we now provide a table giving the characters for the proximal epiphysis of our hypothetical Protsimio-human. We have obtained these by considering each index in turn, giving weight to the drift of development in *Simiadae*, *Simiinae* and Primogenial Man. At times it almost seemed to us that the branch-point of the *Cebidae* might for certain characters have even more suggestiveness than that of the *Simiadae*, but we did not venture to follow up any hint we seemed to discover in this

TABLE XLII. *Characters of the Proximal Epiphysis of the Hypothetical Protsimio-human.*

Character	Recent Gibbon	Protsimio-human	Recent Chimpanzee	Recent Man
Vert. Diameter of Head ...	15·0	36·0	36·15	43·92
Horiz. Diameter of Head ...	15·1	35·8	36·2	43·54
Min. Horiz. Diam. of Neck ...	7·55	19·7	17·6	24·14
Min. Vert. Diam. of Neck ...	10·0	25·2	22·7	31·74
Capito-collar Length	26·05	51·5	62·4	72·50
Length of Neck	18·5	33·5	46·3	50·54
Robusticity of Head	15·55	22·3	23·2	20·60
Ellipticity of Head	100·7	99·4	100·15	98·98
Ellipticity of Neck	75·7	78·0	77·3	76·30
Secondary Index of Neck ...	49·95	55·0	48·5	55·38
Lemotic Index	9·55	10·4	14·2	11·87
Head-Bust Ratio	58·15	69·9	58·0	61·01
Primary Bust Ratio	13·4	15·8	19·8	16·95
Secondary Bust Ratio ...	13·4	16·0	20·1	17·06
Bust Shaft Index	14·85	19·0	24·3	20·05
Capital Ratio	7·75	11·1	11·5	10·26
Capito-bicondylar Ratio ...	59·4	58·1	52·2	58·62
Epiphysial Ratio	103·05	83·1	90·0	96·55
Collar Angle	114°·5	120°·5	133°·3	130°·4

sense. In selecting our indices—which are of course only round values—occasionally some latitude was possible; but not infrequently we were driven almost at once to a very small range of possible values. What impressed itself upon us when the values were obtained and recorded alongside those of Recent Man based on a mean of the two sexes, is how closely our hypothetical bone lies between the chimpanzee and the human femur. Prot-simio-human, Recent Chimpanzee and Recent Man present on the whole an association in marked contrast to the Recent Gibbon. There are certain gibbonlike characters in the protsimio-human femur, *e.g.* its Lemotic Index and Bust Ratios, but on the whole it is not hylobatic but troglodytic, and what is more its troglodytism is often nearer that of Recent Man than of the Recent Chimpanzee. Thus it is quite possible that the "missing link" when found will be considerably more human than, say, gorilloid—a point which we shall discuss more at length in Chapter X.

CHAPTER IX

CHARACTERS OF THE DISTAL EPIPHYSIS

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(i) *Introductory.*

Unfortunately for the Distal Epiphysis we lose the help of the chief French writers, who have so far contributed largely to our comparative study of femoral characters. With rare exceptions the French seem to have avoided the study of the lower end of the femur. Antony (with Rivet) and Bertaux give the bicondylar width for some of the anthropoids, but not as far as we are aware for man. Rodriguez fails us entirely, and not one of the writers on neolithic man in France has paid attention to the condyles. In England matters are as bad; putting aside Flower and Garson whose studies on the femora of prehistoric and primitive man are of no importance from present day standards, we note that Scott with his unique collection of Moriori and Maori femora has given no measurements of the distal epiphysis. Parsons has given us only the breadth of the distal articulation[1]. Thus up to the present the distal epiphysis has been chiefly studied and that not very amply by the Germans. The two anthropologists who have given it most attention are Bumüller and Klaatsch. Both are on this point suggestive but their conclusions are not of any great validity. Klaatsch, because here, as elsewhere, he thinks he can argue as to races by giving the measurements of one or two selected individual bones—wholly disregarding the large variations within a race. Bumüller because with apparently ample material he contents himself with measuring small portions of it. Neither show any knowledge of the probable errors of short series, or recognise that even if they dealt with two series of fifty femora, these might, especially if due regard

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[1] In order to form some idea of the bicondylar width of the Rothwell and Portuguese femora we have formed the regression equations for our London material of bicondylar width on maximum length and on vertical diameter of head, both these characters having high correlations with the bicondylar width. These equations are as follows:

♂ R.: Mean bicondylar width = 32·03 + ·1077 × Mean Maximum Length,
♂ L.: Mean bicondylar width = 37·03 + ·0951 × Mean Maximum Length,
♀ R.: Mean bicondylar width = 44·39 + ·0628 × Mean Maximum Length,
♀ L.: Mean bicondylar width = 36·695 + ·0813 × Mean Maximum Length,

and again: ♂ R.: Mean bicondylar width = 30·94 + 1·0456 × Mean Vertical Diameter of Head,
♂ L.: Mean bicondylar width = 26·50 + 1·1312 × Mean Vertical Diameter of Head,
♀ R.: Mean bicondylar width = 30·89 + ·9540 × Mean Vertical Diameter of Head,
♀ L.: Mean bicondylar width = 23·79 + 1·1308 × Mean Vertical Diameter of Head.

We have:

	Mean Length		Mean Vertical Diameter of Head	
	Rothwell English[1]	Modern Portuguese[2]	Rothwell English[3]	Modern Portuguese[4]
♂ R.	456·25	448·06	49·13	46·64
♂ L.	460·05	447·82	49·15	46·53
♀ R.	418·09	406·11	42·74	40·67
♀ L.	421·94	403·81	42·14	40·25

[1] Bibl. No. 118, p. 18.
[2] Bibl. No. 118, p. 19.
[3] As determined by us.
[4] Bibl. No. 118, p. 24.

From these we deduce by the above equations:

Bicondylar Width.

	Rothwell English			Portuguese		
	From Maximum Length	From Vertical Diameter of Head	Mean of Preceding Values	From Maximum Length	From Vertical Diameter of Head	Mean of Preceding Values
♂ R.	81·17	82·31	81·74 [76·57]	80·29	79·71	80·00 [74·81]
♂ L.	80·78	82·10	81·44 [76·91]	79·62	79·13	79·38 [74·68]
♀ R.	70·65	71·67	71·16 [67·33]	69·89	69·69	69·79 [65·83]
♀ L.	71·00	71·44	71·22 [67·48]	69·52	69·30	69·41 [65·56]

The quantities in square brackets are the widths of the distal articulation. We do not wholly agree with Parsons' own means, 75, 77, 68 and 67 respectively.

We see from these results that the mean differences of the bi-epicondylar width and the width of the articulation of the distal epiphysis as taken by Parsons are

♂ R. 5·2, ♂ L. 4·6, ♀ R. 3·9, ♀ L. 3·8,

or say roughly 5 mm. for a male and 4 mm. for a female bone. We have used the reconstructed values given above in our tables, so as to include the Rothwell English and the Portuguese.

were paid to sex and side, be inadequate for the determination of racial differences. Nevertheless their discussions will remain highly suggestive for further biometric work as longer series are collected and measured. We commence our discussion with the absolute and relative sizes of the bicondylar width.

(ii) *Bicondylar Width and Bicondylar Ratio.*

The table on the following page contains all the data we have been able to collect as to the bicondylar width.

We extract the following summary:

Lemuroids	13·53
Cebidae	19·92
Simiadae	29·34
Dryopithecus rhenanus[1] ...	41·1
Greater Anthropoids ...	69·61
Neanderthal Type (6) ...	87·6
Galley Hill	[88·0 ??]
Cromagnon Type (5) ...	92·7
Grimaldi Type (2)	93·0
Recent Man (Racial Mean)	♂ 79·57 (30) ♀ 69·90 (24)
,, ,, (Racial Mean)	♂ + ♀ 74·73
17th century Londoners	♂ 79·76, ♀ 70·00
,, ,, ,,	♂ + ♀ 74·88

We see that our 17th century Londoners serve extremely well as type for this character in Recent Man. The usual feature is present—if anything more emphasised in the absolute size of the distal epiphysis—*i.e.* the continuous rise up to the Cromagnon Type and then the rapid fall to Recent Man, who has again become more apelike.

The type forms are the *Lorisinae* for the Lemuroids, *Brachyurus*, or since our specimen was young, probably better *Cebus* for the *Cebidae, Cercocebus* for the *Simiadae*, and the Chimpanzee for the Greater Anthropoids.

Before we proceed to a more detailed discussion of Table XLIII something must be said about the construction of the table. We are really responsible for the bulk of the entries having calculated the means when they have not been given or when given recalculated them. The numbers in square brackets are the probable values for either sex when the intermediate mean value is that for pooled sexes. We obtained these as follows: The sex ratios of female ($\bar{x}_f$) to male ($\bar{x}_m$) mean were taken in five long series and the mean of these five values taken as the true sex ratio. For Bicondylar Width $\bar{x}_f/\bar{x}_m = \cdot 8841$ and for Bicondylar Ratio $\bar{x}_f/\bar{x}_m = \cdot 9651$. Hence we deduce on the hypothesis of equality in number of the sexes:

$$\left.\begin{aligned} \bar{x}_f &= \cdot 9385\ \bar{x}_{m+f} \\ \bar{x}_m &= 1\cdot 0615\ \bar{x}_{m+f} \end{aligned}\right\} \text{ for Bicondylar Width.}$$

$$\left.\begin{aligned} \bar{x}_f &= \cdot 9822\ \bar{x}_{m+f} \\ \bar{x}_m &= 1\cdot 0178\ \bar{x}_{m+f} \end{aligned}\right\} \text{ for Bicondylar Ratio.}$$

Of course these will only give for small series rough approximate values.

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[1] Recent Gibbon 28·60, *Ateles* 32·9. The Recent Gibbon is seen as a degenerate form of its fossil predecessor, and it is even more slender than *Ateles.*

TABLE XLIII. *Table of Bicondylar Widths.*

	Race	Bicondylar Width		Source
Lemuroids	*Tarsiidae*	6·9 (2)	Mean 13·53	Pearson and Bell
	Galaginae	8·5 (6)		,,
	Lorisinae	12·0 (6)		,,
	Indrisinae	17·5 (8)		,,
	Lemurinae	17·7 (18)		,,
	Chiromyrdae	18·6 (2)		,,
Cebidae	*Hapalinae*	10·1 (16)	Mean 19·92	Pearson and Bell
	Nyctipithecinae	13·0 (8)		,,
	Pithecia	16·8 (2)		,,
	Cebus	18·95 (6)		,,
	Brachyurus	19·9 (2)		,,
	Lagothrix	22·0 (2)		,,
	Mycetes	25·7 (2)		,,
	Ateles	32·9 (4)		,,
Simiadae	*Cercopithecus*	22·6 (8)	Mean 29·34	Pearson and Bell
	Macacus	29·0 (14)		,,
	Semnopithecus	29·0 (10)		,,
	Cercocebus	29·5 (4)		,,
	Cynocephalus	36·6 (8)		,,
	Dryopithecus rhenanus	41·1 (1)		Cast
	Gorilla	85·12 (33)	Mean 69·61	Antony & Rivet Hepburn, Authors
	Chimpanzee	65·72 (22)		Antony & Rivet Hepburn, Authors
	Orang-utan	58·00 (3)		Hepburn, Authors
	Gibbon	28·60 (17)		Antony & Rivet Hepburn, Authors
	Pithecanthropus erectus	78·0 (1)		Photographs
	Neanderthal	89·6 (1)	Neanderthal Type (6) 87·6	Cast
		87 (1)		Schaaffhausen
	Spy	93·6 (1)		Cast
		90 (1)		Fraipont & Lohest
	Homo mousteriensis (*Hauseri*)	83·3? (1)		Cast

Race	Bicondylar Width		Source
	♂	♀	
La Chapelle-aux-Saints	84·0?		Photographs
Galley Hill	(88·0??)		Mere apprecia-tion from cast
Homo aurignacensis (*Hauseri*) ...	86·0		Photographs
Ancient Persians (Anau) ...	87·5 (2) ♂?		Mollison
Fuegians (1st Series)	[85·63] 80·67 (9)	[75·71]	Hultkrantz
Swiss Alemanns	83·4 (c. 88)	74·0 (c. 88)	Schwerz
Modern British	83·29 (33)	76·33 (3)	Hepburn
East Indians	82·88 (8)	66·50 (2)	,,
Bolognese	82·7 (20)	74·1 (23)	Zanolli
Romano-British	82·33 (3)	—	Hepburn
Modern Swiss (1st Series) ...	82·0 (?)		Martin
Rothwell English	81·59 (174)	71·18 (105)	Parsons
Eskimo	81·50 (2)	69·75 (2)	Hepburn
Australians (1st Series)	81·00 (5)	69·67 (3)	Prochownick
Modern Swiss (2nd Series) ...	80·9 (22) ? ♂		Schwerz
Modern Bavarians	80·85 (346)	[71·48] (?)	Bumüller
Bajuvars, Swabians, Alemanns from Row Graves	80·06 (16)	72·67 (3)	Lehmann-Nitsche
Maori (1st Series)	79·94 (8)	73·83 (3)	Hepburn
Australians (2nd Series) ...	79·85 (2)	70·6 (2)	Pearson and Bell
17th century Londoners ...	79·76 (319)	70·00 (216)	,,
Modern Portuguese	79·69 (144)	69·60 (126)	Tamagnini and de Campos
Fuegians (2nd Series)	[79·6] 75·0 (5)	[70·39]	Martin
Chinese	79·50 (2)	—	Hepburn
Japanese	79·4 (20)	71·5 (20)	Koganei
Laplanders	79·00 (2)	65·00 (2)	Hepburn
Negroes (Various)	78·80 (10)	72·00 (3)	,,
Aino	78·6 (36)	71·5 (22)	Koganei
Australians (3rd Series) ...	77·45 (12)	60·75 (2)	Hepburn
Fijians (Viti)	75·83 (24)	69·00 (7)	Prochownick
Caroline Islanders	75·00 (8)	67·00 (4)	,,
Guanches	75·00 (2)	—	Hepburn
Maori (2nd Series)	[74·09] 69·8 (5)	[65·51]	Mollison
Bushmen	72·50 (2)	—	Hepburn
Andamans	67·38 (8)	62·33 (3)	,,
Neolithic Swiss Dwarfs	67·7 (3)		Schwerz

The numbers in the table are in the bulk of cases so few, that this combined with differences of locality, of methods of measurement, of standard for rejection of cases of damaged epicondyles, and *probably of manner of sexing*, causes those cases for which we have two series to appear in widely divergent positions in the table. We have hesitated to screen these divergences by pooling such remarkably different values as those given by Hultkrantz and Martin for Fuegians, by Prochownick and Hepburn for Australians and by Hepburn and Mollison for Maori! Results of but small value can be deduced from this table of absolute size of the distal epiphysis.

The gorilla is the only ape with a distal epiphysis sensibly greater than that of Recent Man, and in absolute size he separates Primogenial from Recent Man. The Galley Hill value of the Bicondylar Width depends on mere appreciation from the cast, but it was a careful appreciation. If any weight can be given to it, this appreciation confirms the conclusion we have drawn from other characters also, that the Galley femur is closer to the Neanderthal Type than to Recent Man. The considerable differences in Bicondylar Width as we have determined them from the casts and as they have been measured on the originals in the case of the Neanderthal femur by Schaaffhausen and of the Spy femur by Fraipont and Lohest point either to considerable changes with the setting of the plaster of Paris, in cast or mould, or to marked differences in mode of measurement or again to instrumental errors. Modern British (? Scotch), Rothwell English, and Modern Swiss are nearer to Primogenial Man of the Neanderthal Type than Prochownick's Australians, and *all* Modern Europeans are interposed between this type of Primogenial Man and Hepburn's Australians. In this feature as in so many others we fail to find those links between the Australian aborigines and Primogenial Man which some authorities have emphasised. Certainly on the basis of absolute size of the distal epiphysis there is nothing to show any close relationship between Modern Primitive Man and Primogenial Man of the Neanderthal Type.

With the exception of two short and doubtful series of great Bicondylar Width, the upper part of the table so far as Recent Man is concerned consists roughly of Modern Europeans and their progenitors, then follow the Asiatics and Negroes, while the femora of small distal epiphysis belong to "fringe" races represented by series sadly deficient in numbers. Divergence of method and smallness of series render it impossible to place in their true position such essentially important races as Fuegians, Eskimo, Laplanders and Maori. *Pithecanthropus erectus* as usual is purely human.

If we turn now to the relative size of the distal epiphysis as measured by the Bicondylar Ratio conclusions of greater value can be drawn. In comparing Klaatsch's Proximal Breadth Ratio based on the trochanteric length (p. 234) we have already given a partial table of the Bicondylar Ratio. We did this to demonstrate that nothing was gained by using the trochanteric in place of the maximum length of the femur. The present table is more complete. In forming it we have recalculated the bulk of the indices from the data provided in the sources indicated or rather in the majority of cases calculated them for the first time. We have further where needful reconstructed maximum length from oblique length and used our own judgment as to other points of correction and modification. Thus the "source" column of the table by no means denotes that the authors cited are in any way responsible for the indices given.

This table of relative size is clearly more self-consistent than the previous one for absolute size. Where we have two series of the same race, or series of closely allied races, their position is far nearer, and the general serial order is from the evolutionary standpoint far more satisfactory. Galley Hill, if we can give any weight to its index, falls well into the Neanderthal group. *Homo aurignacensis* (*Hauseri*) and *Pithecanthropus erectus* fall into the lower part of the modern human group. *Pithecanthropus erectus* is quite as much like the Andaman as he is like the Gibbon. Gibbon excepted, the Greater Anthropoids head the serial order; then follows Primogenial Man of the Neanderthal Type; then come Japanese, Aino and Chinese, with Eskimo and Fuegians; then the Modern Europeans with their antecedent races[1] and finally Fijians, Australians and Maori.

The summary for the Bicondylar Ratio of the Primates is as follows:

Lemuroids	13·46 (Type *Lemurinae*)
Cebidae	15·36 (Type *Hapalinae*)
Simiadae	15·29 (Type *Cercopithecus*)
Dryopithecus rhenanus	14·3
Gibbon	14·08
Ateles	14·8
Greater Anthropoids	22·52 (Type Orang[2])
Neanderthal Type (6)	20·8
Galley Hill	[20·8 ? ?]
Cromagnon Type	18·4
Grimaldi Type	19·0 ?
Recent Man (Racial Mean)	♂ 17·99 (30) ♀ 17·32 (26)
,, ,, ,, ,,	♂+♀ 17·65
17th century Londoners	♂ 17·83 ♀ 17·25
,, ,, ,,	♂+♀ 17·54

Again we see that our 17th century Londoners are very close to type for Recent Man. All the usual features occur. *Cebidae* and *Simiadae* both increase in index on the Lemuroids and this confirms the view that the *Cebidae* did not depart from the main line of descent—as Haeckel has it—before the Lemuroid stage. The Gibbon group is seen as side tracked on the way to the Greater Anthropoids. The Neanderthal Type has less relative size of distal epiphysis than the Anthropoids—a more Chimpanzee-like proportion. Thence we descend by Cromagnon to Recent Man, who while very divergent from the Gibbons stands between the *Simiadae* and the Greater Anthropoids.

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[1] A bad exception occurs in the femora from the German Row Graves. We attribute this entirely to the paucity of the numbers and to our being unable to associate individual bicondylar widths with individual maximum lengths.

[2] The type of the *Simiinae* if we had included *Hylobates* would again have been the Chimpanzee.

TABLE XLIV. *Table of the Bicondylar Ratios.*

	Race	Bicondylar Ratio		Source
Lemuroids	*Tarsiidae*	10·75 (2)	Mean 13·46	Pearson and Bell
	Indrisinae	11·6 (8)		,,
	Lemurinae	13·7 (18)		,,
	Galaginae	14·35 (6)		,,
	Chiromyrdae	14·95 (2)		,,
	Lorisinae	15·4 (6)		,,
Cebidae	*Brachyurus*	12·8 (2)	Mean 15·36	Pearson and Bell
	Pithecia	12·95 (2)		,,
	Nyctipithecinae	14·7 (8)		,,
	Ateles	14·8 (4)		,,
	Hapalinae	15·3 (16)		,,
	Cebus	15·85 (6)		,,
	Mycetes	16·9 (2)		,,
	Lagothrix	19·65 (2)		,,
Simiadae	*Cercocebus*	13·45 (4)	Mean 15·29	Pearson and Bell
	Semnopithecus	14·6 (10)		,,
	Cercopithecus	15·8 (8)		,,
	Cynocephalus	15·9 (8)		,,
	Macacus	16·7 (14)		,,
Dryopithecus rhenanus ...		14·3 (1)		Cast
Gorilla		23·92 (33)		Antony & Rivet Hepburn, Authors
Orang-utan		22·10 (3)		Hepburn, Authors
Chimpanzee		21·55 (22)		Antony & Rivet Hepburn, Authors
Gibbon		14·08 (17)		Antony & Rivet Hepburn, Authors
Pithecanthropus erectus ...		17·4 (1)		Photographs
Neanderthal		20·1 (1) 19·9 (1)		Cast Schaaffhausen
Spy		21·8 (1) 21·4 (1)		Cast Fraipont & Lohest
Homo mousteriensis (*Hauseri*)		21·7? (1)		Cast

Race	Bicondylar Ratio ♂	Bicondylar Ratio ♀	Source
La Chapelle-aux-Saints ...	19·5 (1)		Photographs
Galley Hill	20·8?? (1)		Mere appreciation from cast
Homo aurignacensis (*Hauseri*)	17·6 (1)		Photographs
Laplanders	19·54 (2)	17·94 (2)	Hepburn
Japanese	19·42 (20)	18·83 (20)	Koganei
Fuegians (1st Series) ...	[19·34] 19·00 (9)	[18·66]	Hultkrantz
Aino	19·28 (36)	18·71 (22)	Koganei
Chinese	19·14 (2)	—	Hepburn
Eskimo	18·81 (2)	16·47 (2)	,,
Fuegians (2nd Series) ...	[18·57] 18·25 (5)	[17·93]	Martin
Caroline Islanders	18·39 (8)	16·57 (4)	Prochownick
Bolognese	18·35 (20)	18·05 (23)	Zanolli
Ancient Persians (Anau) ...	18·34 (2)	—	Mollison
Romano-British	18·14 (3)	—	Hepburn
British	18·02 (33)	17·80 (3)	,,
Modern Bavarians	17·97 (346)	[17·34]	Bumüller
Modern Swiss (1st Series) ...	17·96 (?)	[17·33]	Martin
Neolithic Swiss Dwarfs ...	17·96 (3)		Schwerz
Modern Swiss (2nd Series)...	17·94 (22)	[17·31]	,,
Swiss Alemanns	17·94 (c. 88)	17·52 (c. 88)	,,
17th century Londoners ...	17·83 (313)	17·25 (211)	Authors
Rothwell English	17·81 (174)	16·95 (105)	Parsons
Modern Portuguese... ...	17·79 (144)	17·19 (126)	Tamagnini and de Campos
Maori (1st Series)	17·76 (8)	17·81 (3)	Hepburn
[Australians (1st Series) ...	17·65 (2)	17·65 (2)	Pearson and Bell]
Andamans	17·62 (8)	16·95 (3)	Hepburn
Maori (2nd Series)	[17·55] 17·24 (5)	[16·93]	Mollison
Fijians (Viti)	17·49 (24)	17·10 (7)	Prochownick
Bushmen	17·31 (2)	—	Hepburn
Australians (2nd Series) ...	17·19 (5)	16·36 (3)	Prochownick
East Indians	17·14 (8)	16·36 (2)	Hepburn
Bajuvars, Swabians and Alemanns from Row Graves	16·99 (16)	17·61 (3)	Lehmann-Nitsche
Negroes (Various)	16·93 (10)	16·70 (3)	Hepburn
Guanches	16·54 (2)	—	,,
Australians (3rd Series) ...	16·49 (12)	14·72 (2)	,,

On the whole the table seems so satisfactory considering the slenderness of the data, that we would urge femoralogists to give the Bicondylar Ratio, wherever the state of the epicondyles permits. We should like to see the position of the Negroes more adequately established, to find the Guanches removed from their present anomalous position—worthless for it depends on the two femora of one skeleton—and to ascertain the serial position of Malays, Polynesians, Melanesians and American Indians. This ought to be possible by aid of the ample material in Paris, and we specially commend this problem to our Parisian colleagues.

It may not be without service to institute a terminology for this index and we suggest:

Hyperdolichothemeliotic over 20, Greater Anthropoids and Primogenial Man.
Dolichothemeliotic over 18·75 but less than 20, Japanese, Aino, Chinese, Eskimo and Laplanders.
Mesothemeliotic over 17·75 to 18·75, Modern Europeans and their forbears.
Brachythemeliotic over 17·0 to 17·75, Fijians, Andamans and Bushmen.
Hypobrachythemeliotic below 17·0, Negroes and Australians and Lesser Apes.

It may be desirable to modify the exact ranges when more data are available, but for the present the above limits seem to express fairly rounded classes. We see as for a number of other characters the central position of the higher races, while the Greater Anthropoids with Primogenial Man and the Lesser Apes with Primitive Modern Man form the flanks.

(iii) *The Condyles: Measurements taken and suggested: Band-radial Indices.*

(*a*) Before we consider the condylar indices it is desirable to ascertain what material we have at present available for the absolute condylar lengths[1]. These lengths are fourteen in all, of which we have ourselves rejected eight and only ascertained six namely those marked in the list below with an asterisk.

Lateral Condyle	*Mesial Condyle*
1. Maximum or Natural Length*.	2. Maximum or Natural Length*.
3. Oblique Length or Projection* of (1) on Sagittal Plane.	4. Oblique Length or Projection* of (1) on Sagittal Plane.
5. Maximum transverse Breadth.	6. Maximum transverse Breadth.
7. *a*. Anterior Arc of Articular Surface. *b*. Posterior Arc of Articular Surface.	8. *a*. Anterior Arc of Articular Surface. *b*. Posterior Arc of Articular Surface.
9. Vertical Band-Radius*.	10. Vertical Band-Radius.
11. Horizontal Band-Radius*.	12. Horizontal Band-Radius.

From these a great variety of indices may be obtained. Clearly any femoralogist who has a series of 800 to 900 femora to deal with must make a selection from these measurements, if he wishes to complete his work within a reasonable number of years. We took 1, 2, 3, 4, 9 and 11. We regret to some extent having taken 4 only on a limited portion of our material. We attempted 5 and 6 and found them so indefinite and uncertain chiefly owing to wear that we concluded that they could not be treated as measurements of primary comparative value. 7 and 8 are suggested by Bumüller, but he admits that on the mesial condyle they are hard to determine; we found them extremely indefinite, so indefinite on the lateral as well as on the mesial condyle that we believe them too precarious to be of value in any exact research[1]. Of course our femora had been probably more than 200 years underground and were accordingly much worn. We cannot say what would be the rule on dissecting room material. Bumüller lays stress on what he terms the Condylar-articular Surface Index, *i.e.* 100 anterior arc/posterior arc. He (*loc. cit.* p. 82) states that the compound nature of the condylar-articular surface is easily recognisable in Man and in the Apes. We admit this but find the exact boundary line between the two and in particular Bumüller's limiting point not ascertainable in our femoral series. He gives for *twenty-five* femora only the mean Condylar-articular Surface Index as 56·6 for the lateral and 20·8 for the mesial condyle. He gives no measurements whatever for Apes, but remarks:

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[1] Bertaux (Bibl. 52, p. 199) has a measure of the internal condyle which he terms the "Encoche condylienne." He defines it as follows:

> Mesure de l'encoche du condyle interne au centre de l'échancrure intercondylienne; chez les hommes nous avons pris aussi la distance au plan tangent postérieur du condyle interne.

We have not used these measurements as we could not be certain of what they exactly correspond to.

> Die verschiedene Grösse der vorderen Partien macht sich auch in der Form der ganzen Kniegelenkfläche geltend. Dieselbe geht auf der lateralen Seite weiter nach oben, sie ist hier gleichsam hinaufgezogen. Die Begrenzung derselben ist daher nicht eine halbkreisförmige, sondern stellt eine gekrümmte, nach oben bald konvexe, bald gerade, bald konkave schiefe Linie dar, deren höchster Punkt auf der lateralen Seite liegt. Diese Form der Kniegelenkfläche und das Verhältniss der vorderen zur hinteren Partie am medialen Condylus ist für den Menschen charakteristisch, obwohl auch beim Affen in einzelnen Fällen ein ganz ähnliches Verhalten vorkommt. (*L.c.* p. 83.)

No statistics are provided of the relative frequency in the Ape of this asserted human characteristic, and the suggestion lacks that quantitative determination which, however laborious, alone can justify later investigators spending valuable time over a difficult and obscure measurement.

(*b*) With regard to the measurements 9 to 12, Bumüller states that 9 and 11 only are taken ("Wird nur am lateralen Condylus abgenommen," *l.c.* S. 141). We believe that the introduction of these measurements and the resulting "Band-radial Index" = 100 × vertical radius/horizontal radius, are due to Bumüller. He gives no reason for confining the measurements to the lateral side[2] but economy of labour and increased difficulty at least plead for such restriction. Bumüller has determined this index on five greater anthropoid femora, one gibbon's femur, and on four femora of monkeys. The following are his results[1]:

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[1] His description of the determination of these arcs is the following: "Die Länge der vorderen und hinteren Partie der medialen und lateralen Gelenkfläche wird mit dem Bandmaass bestimmt. Vordere Partie: je vom äusseren oberen Eck der Gelenkfläche bis zu dem einspringenden Winkel bei den Eindrücken der Menisci; ist medial öfters nicht exakt abzunehmen; hintere Partie: von genannten Winkel bis zum Ende der überknorpelten Fläche. Die vordere Partie wird am äusseren Rande, die hintere in der Mitte der Gelenkfläche gemessen." Bibl. 81, p. 141. It will be seen that the terminal of the anterior arc and the start of the posterior arc require the determination of two separate points. In the great bulk of cases these were not to be found on our femora with any adequate degree of accuracy.

[2] The sentence "Diese Bänder sind gespannt wenn der Fuss gestreckt ist, erschlaffen dagegen—besonders auf der lateralen Seite—bei gebeugtem Femur" (*l.c.* p. 81) contains, perhaps, his reason.

Chimpanzee ♂ R.	90	Gibbon (*Hylobates concolor*) L.	87
Orang ♂ R.	90	*Inuus sylvanus* R.	70
" ♂ L.	85	*Cynocephalus gelada* R.	74·1
" ♀ R.	83·3	*Lichanotus Indri* R.	81·8
" ♀ L.	81·25	" " L.	81·8

His human sample consists of only *thirty* femora, and he states the mean as 112·3 and the range 100 to 128·6. He gives *Pithecanthropus erectus* the value 67 to 85. Here again our criticism repeats itself: Bumüller has made a suggestion, which may be a good one, but his quantitative evidence is wholly inadequate to justify *à priori* the adoption of this measurement generally. We did, however, add these measurements to our list, notwithstanding the very great uncertainty as to the exact epicondylar *point* from which the band-radii are to be measured[2]. The ligaments are attached to the border of an area often irregular, and with no well defined "centre"; it is especially hard to determine this centre in long interred bones. Again while we allow something to the mechanical stretching in the unflexed leg, we think it probable that at least a considerable portion of the tautness of the ligament in the unflexed state may be due to physiological causes. However the point appeared to be one in which the difference in posture between Man and the Apes might really lead to a differential criterion of the pithecoid and the human. Accordingly we did our best to obtain an independent determination of Bumüller's Band-radial Index. We paid no regard to his values of which the observers were not cognisant when taking their own measurements. The following table covers our own material.

TABLE XLV. *Table of Band-radial Indices.*

	Race	Band-radial Index		Race	Band-radial Index
Lemuroids	*Tarsiidae*	70·9 (2)	Mean 85·47	*Dryopithecus rhenanus*	94·9 (1)
	Galaginae	75·15 (6)		Gorilla	97·64 (7) Mean 93·85
	Chiromyrdae	77·45 (2)		Chimpanzee	97·25 (2)
	Lorisinae	81·9 (6)		Orang-utan	82·7 (5)
	Lemurinae	98·4 (18)		Gibbon	97·8 (2)
	Indrisinae	109·0 (8)		*Pithecanthropus erectus*	112·0?? (1)
Cebidae	*Hapalinae*	91·6 (16)	Mean 101·89	Neanderthal	98·4?? (1)
	Ateles	95·4 (4)		Spy	98·9?? (1)
	Pithecia	101·7 (2)		17th century Londoners	♂ 111·94 (337) ♀ 110·78 (227)
	Mycetes	102·7 (2)		Australians	♂ 111·4 (2) ♀ 99·9 (2)
	Nyctipithecinae	104·1 (8)		[Bumüller's Bavarians	♂ 112·3 ♀ ?]
	Cebus	105·3 (6)			
	Lagothrix	105·4 (2)			
	Brachyurus	108·9 (2)			
Simiadae	*Cynocephalus*	93·8 (8)	Mean 97·68		
	Cercopithecus	96·7 (8)			
	Macacus	97·7 (14)			
	Cercocebus	99·6 (4)			
	Semnopithecus	100·6 (10)			

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[1] *Loc. cit.* p. 82 and Tabelle II, p. 112.

[2] The difficulty increases immensely when we have to deal with very small apes or lemuroids.

Now these results are of considerable interest and if slender are at least suggestive. We have:

Summary for Band-radial Index.

Lemuroids	85·47 (Type *Lorisinae*)
Cebidae	101·89 (Type *Pithecia*)
Simiadae	97·68 (Type *Macacus*)
Dryopithecus rhenanus	94·9
Ateles	95·4
Recent Gibbon	97·8
Simiinae (including Gibbon)	93·85 (Type Chimpanzee)
Neanderthal Type	98·4 ?
Recent Man (17th century Londoners)	111·36

Our values differ very widely from Bumüller's except in the case of Recent Man and the Orang where he has 112·3 and 84·9. Our values for the Gibbon are much in excess of his and more in keeping with the fossil *Dryopithecus* and with *Ateles*. 14 femora of *Macacus* give us 97·7 as against his 74·1 for a single femur. Further we find the bulk of the genera of *Cebidae* have an index in excess of 100 and *Semnopithecus* is over 100 among the *Simiadae*, while among the Lemuroids the *Indrisinae* occupy an exceptional, if not remarkable position. Thus we cannot accept the statement that for the apes the index is always under 100. Further for man himself our tables, p. 295, show that for a considerable percentage of cases we have found, measuring to the best of our ability, this index under 100. Still generally we confirm Bumüller's view that for the Anthropoids the Band-radial Index is less than 100 and that for Man the mean is markedly over 100. Our adequate sample of 337 males gives an index of 111·94, which is in absolute correspondence with Bumüller's 112·3 for 30 cases[1]. A suggestive but by no means demonstrated point is that the doubtful values for Primogenial Man of the Neanderthal Type are slightly less than 100, but bigger than the value for the Gorilla. If uprightness be markedly correlated with the Band-radial Index, then if we could possibly trust our values, Primogenial Man was intermediate in uprightness of gait between Modern Man and the Apes. It would be a useful, if difficult, task to ascertain the Band-radial Index in the long Paris series of Neolithic French. Of course this characteristic of gait is from the evolutionary standpoint a very important one, but the reader must be reminded that the data we have given for Primogenial Man are not only slender, but depend on very doubtful determinations. Further we must not overlook the fact that for the bulk of characters dealt with in this chapter, we have found that Primogenial Man is not a link between the Anthropoid Apes and either modern or primitive races of Man.

If we turn to *Pithecanthropus erectus* all we can say is that we determined as accurately as we were able the Band-radii on the illustrations of Dubois. We are and were unprejudiced as to whether the Trinil femur is pithecoid or human, and did not notice that the bulk of its characteristics were human and not pithecoid until the indices were worked out much later. We put no faith whatever in our value, because both band-radii were queried on determination. But our value is so human and Bumüller's is so pithecoid—indeed almost subpithecoid (except for an anomalous Orang of our own!)—that we feel quite safe in asserting that no criterion of the pithecoid character of the Trinil femur can be based as Bumüller supposes[1] on the Band-radial Index as found from the reproductions[2]. Our experience of more than 800 femora interred for only 200 years makes us gravely doubt whether it could be accurately determined on the Trinil femur itself. At any rate the fact that such widely divergent estimates are possible renders Professor Dubois' responsibility in postponing for more than twenty years an adequate scientific investigation of this femur very grave.

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[1] This exact concordance is of course fortuitous, the standard deviation of the index is from our results (p. 163) between 11 and 12 points. Hence the probable error of Bumüller's result is about 1·5, or all he could legitimately deduce from it was that the index probably lies between 109 and 115.

Another point is of such importance that it must be emphasised here. Out of 30 femora Bumüller found not a single apelike one, *i.e.* a femur with a vertical radius less than the horizontal. His range was 100 to 128. In the 561 London femora that permitted of any determination of the Band-radii we found 120 with indices less than 100 or 21·4 $^{\circ}/_{\circ}$. On the face of it we found 21 $^{\circ}/_{\circ}$ of human femora with an apelike character in this respect, but Bumüller, who in a random sample of 30 should on our scale have found 6, found none. Our range with a larger sample is from 81 to 144, *i.e.* 31 points below and 32 points above the mean. Bumüller's range is 12 points below and 16 above his mean, which at any rate suggests skewness of distribution, although the sample is too small for definite criticism. Now it is open to the reader to assert that our localisation of the "centre" of the band-radii was very poor; it was certainly doubtful in a considerable number of cases. Our only reply can be that we were as accurate as lay in our power both in determination of the centre and in the handling of special gauges constructed for fine work on metals, which we purchased for our work on the condyles. We are willing to give something of our 21 $^{\circ}/_{\circ}$ to the vague character of the measurement, but far from the whole of it, and if this view be correct, it would follow that the human-range crosses the ape-range and that power of upright gait is not *solely* due to the tightening of the *ligamentum femoro-fibulare* mechanically, but has also a physiological origin. If this view be correct, the band-radial index is not for the *individual* an absolute test of the human or the pithecoid, but may on fair sized samples be a good criterion of the greater or less pithecoid character of a human race. From this aspect we would press for the attention of femoralogists to this index; the discovery of its mean values for primitive races, Australians, Fuegians, Moriori, Aino, etc., would be of very great interest, and the requisite material is available.

About the absolute values of the band-radii but little can be said because there is no material beyond our own. Their values in our 17th century Londoners are: horizontal band-radius ♂ 18·90, ♀ 16·81, vertical band-radius ♂ 20·82, ♀ 18·48, the maximum lengths of external condyle being ♂ 62·44 and ♀ 56·12. But the gorilla and chimpanzee have as large, if not larger, band-radii with very much smaller length of external condyle:

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[1] "Der Bandradien Index (*i.e.* of *Pithecanthropus erectus*) ist *zweifellos* ein tierischer und *äffischer*.' *Loc. cit.* p. 131.

[2] See Fig. 2 of Plate XLVI, which is the source of the measurements.

Gorilla:	H. band-radius, 23·1,	V. band-radius 22·5,	Condyle 51·3.
Chimpanzee:	,, ,, 20·1,	,, ,, 19·6,	,, 42·4.

The centre of the femoro-fibular ligament is thus relatively further removed from the anterior border of the condyle in the apes than in man, and the suggestion arises that an index based on this may differentiate pithecoid from human characters. We will term 100 × sum of band-radii/maximum length of external condyle, the Secondary Band-radial Index.

TABLE XLVI. *Table of Secondary Band-radial Indices.*

	Race	Secondary B. R. Index			Race	Secondary B. R. Index		
Lemuroidea	*Tarsiidae*	57·0	(2)	Mean 69·70	*Dryopithecus rhenanus*	86·1	(1)	
	Chiromyrdae	58·2	(2)					
	Galaginae	68·5	(6)		Chimpanzee	91·36	(2)	Mean 86·54
	Indrisinae	70·1	(8)		Gorilla	89·01	(7)	
	Lemurinae	75·25	(18)		Orang-utan	84·13	(5)	
	Lorisinae	89·15	(6)		Gibbon	81·67	(2)	
Cebidae	*Ateles*	71·6	(4)	Mean 82·18	*Pithecanthropus erectus*	68·17??	(1)	
	Nyctipithecinae	74·55	(8)					
	Hapalinae	75·15	(16)		Primogenial Man (mean Neanderthal Spy)	71·03?	(2)	
	Mycetes	80·0	(2)					
	Brachyurus	83·0	(2)					
	Lagothrix	87·8	(2)		17th century London Males	63·61	(337)	
	Pithecia	90·8	(2)		17th century London Females	62·88	(227)	
	Cebus	94·5	(6)					
Simiadae	*Cynocephalus*	70·7	(8)	Mean 77·76	Australians, Males	51·3	(2)	
	Cercopithecus	72·3	(8)		Australians, Females	55·0	(2)	
	Macacus	75·5	(14)					
	Semnopithecus	79·9	(10)					
	Cercocebus	90·4	(4)					

Summary.

Lemuroidea	69·70	(Type *Indrisinae*)
Cebidae	82·18	(Type *Brachyurus*)
Simiadae	77·76	(Type *Macacus*)
Dryopithecus rhenanus	86·1	
Simiinae (including Gibbon) ...	86·54	(Type Orang)
Primogenial Man (Neanderthal Type)	71·03?	
Recent Man (17th century Londoners)	63·25	

The noteworthy point is that the *Cebidae* have advanced further than the *Simiadae*, indeed in the uppermost grade to the anthropoid value, while from Neanderthal Man to Recent Man there has been a reversion to a value scarcely paralleled by the Lemuroids, *Tarsius* and the Aye-Aye excepted.

Our slender material indicates a wider range of difference than even in the case of the primary band-radial index but the same order—Anthropoid Apes, Primogenial Man of the Neanderthal Type, Recent Man—is maintained in the lower portion of the table. The exceedingly doubtful value for the Trinil femur places that femur between Primogenial and Recent Man, as far as *mean* values are concerned, but still within the human range. Its value is far removed from that of the Gibbon. The situation on the condyle of the attachment of the femoro-fibular ligament would we should imagine be closely associated with the supposed arboreal life of *Pithecanthropus erectus*. Could we fully trust the above value of the secondary index for the Trinil femur—which is not possible—it would be an additional strong argument, were such needed, against this femur being that of a giant Gibbon.

The secondary band-radial index seems as likely as the primary to be of marked service in grading the degree of pithecoid character in man. We think both might well be studied in conjunction. In particular the low values obtained for the orang need confirmation, and this might well form part of an extended study of the femur of the anthropoids.

(iv) *Absolute Lengths of the Condyles.*

We have already stated how our own condylar lengths are measured (p. 18), but it may be as well here to consider what other writers have said on the subject. Bumüller grasps fully the importance of the two measurements of the length of the condyles, namely the natural or maximum length and the projected or oblique length. His description of his manner of measurement is, however, not very precise. He writes[1]:

> Natürliche Länge beider Condylen mit dem Schiebezirkel von der höchsten vorderen (Kniegelenkfläche) bis zur höchsten hinteren Erhebung (Maximum der Krümmung) ungefähr in der Höhe des Epicondylus.

"Erhebung" from what? Does it refer to central plane of articular surface of condyle, or to the border of it, or to one or other of these as the case may be? Again what is the "Maximum der Krümmung"? Is it the maximum curvature of the middle section of the condyle, or of its border or of the plane perpendicular to these? In our taking of the "natural" or maximum length we proceeded as follows: The base bar of the calipers was placed over the epicondyle as nearly parallel to the median plane of the condyle as could be estimated and roughly parallel to the standard horizontal plane, the fixed bar and the sliding bar were then brought into contact with the anterior and posterior articular surfaces the base bar being adjusted so as to take the maximum measurement whether it occurred at the border of the articular surface or at points nearer to the median plane. The measurement is roughly at the level of the epicondyle. The main point is that we took not a skew measurement, *i.e.* from, say, a point on border to a point on median plane, but the maximum diameter of a *projection* of the condyle on the median plane of the condyle, whereas the oblique length was the maximum diameter of a projection of the condyle on the standard sagittal plane[2]. If we take the highest and lowest points of the condylar articular surface relative to the standard vertical plane we may get a skew "natural" length, *i.e.* one not parallel to the median plane of the condyle and this does not appear justified. Martin[1] under "Dicke des Condylus" measures the oblique length, so does Lehmann-Nitsche[2], and both confine their attention to the *external* condyle. Klaatsch is very brief in his statement:

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[1] Bibl. 81, S. 141 (22).

[2] That is the plane perpendicular to the standard horizontal and vertical planes through the intercondylar point.

> Die Länge der Kondylen. So bezeichnet man wohl am besten den grössten Durchmesser der Kondylen in der Richtung von vorn nach hintern (Bumüller)[3].

Klaatsch does not appear to have noticed that Martin and Lehmann-Nitsche are measuring the oblique length, namely Bumüller's "Projectionslänge des *condylus externus*" or the greatest height of the condyles above the base-board of the osteometer when the bone is in the standard position. This as Bumüller with some truth observes[4] may be the projection length of the *condylus internus* in the case of many apes. Hultkrantz[5] uses the term "Dicke des *condylus externus*," and we believe has measured the oblique length. Klaatsch uses both Bumüller's and Hultkrantz's results and adds others of his own. We are inclined to believe he has really measured the oblique lengths, but his wording just quoted suggests the maximum length.

The question which lengths have been measured is of great importance, because the lengths' difference, upon which great stress has been laid as a criterion of pithecoid character, is very diverse when taken on the natural and when taken on the oblique lengths. As a matter of fact when taken on the natural lengths we are measuring a true *size* difference in the two condyles, but when taken on the oblique lengths we are largely measuring a *positional* difference of the two condyles. Thus Bumüller starts by saying that the external or lateral condyle in man is "kräftig entwickelt," but the internal or mesial condyle is "weniger kräftig entwickelt," while the reverse holds for the anthropoids and most apes. He says that this difference of size need not be measured, but is sensible if the bone be placed on a horizontal plane[6]. It is perfectly true that the mesial condyle in the standard position of the bone is as a rule outtopped by the lateral condyle, and this is largely a result of position and not of absolute size, the mesial condyle slopes far more to the standard sagittal plane, than the lateral and this Bumüller appears to admit at the bottom of the page just cited:

> Legen wir das femur mit seiner dorsalen Seite horizontal auf, so steht die äussere Fläche des *Cond. lat.* ziemlich senkrecht auf der Messplatte, während die äussere Fläche des *Cond. lat.* ziemlich schief nach aussen verlängt.

There are in fact in man such small mean differences in the natural lengths of the two condyles that they could not be appreciated by the unaided eye, as we shall shortly indicate. The more "kräftig entwickelt" appearance of the lateral condyle to which Bumüller refers can only be a result of their difference of position, or to a difference of size measured say by their *breadths* not their lengths. But such breadths are not under discussion[1]. We think it desirable to give our full data on this point in order to counteract the very current view that the lateral condyle is much larger than the mesial.

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[1] Bibl. 63, S. 202.
[2] Bibl. 69, S. 286.
[3] Bibl. 87, S. 613.
[4] Bibl. 81, S. 140 (17).
[5] Bibl. 85, S. 173 (seems to follow Martin).
[6] Bibl. 81, S. 80.

Difference of Natural Condylar Lengths (Lateral – Mesial).

– 8·5 to – 7·5	– 7·5 to – 6·5	– 6·5 to – 5·5	– 5·5 to – 4·5	– 4·5 to – 3·5	– 3·5 to – 2·5	– 2·5 to – 1·5	– 1·5 to – 0·5	– 0·5 to 0·5	0·5 to 1·5	1·5 to 2·5	2·5 to 3·5	3·5 to 4·5	4·5 to 5·5	5·5 to 6·5	6·5 to 7·5	7·5 to 8·5	Total	
—	—	1	2	3·5	15	13·5	23·5	39·5	26·5	21·5	12	15	4	2	—	1	180	17th cent. Londoners ♂ R.
—	—	—	5	7	14·5	23·5	28·5	32·5	28	22	12	6·5	1·5	1	—	—	182	,, ,, ♂ L.
—	·5	·5	1	1·5	7·5	11·5	18·5	22·5	18	25	10	5·5	4	2	—	—	128	,, ,, ♀ R.
1	—	1	2	3	7	13	23	20·5	26·5	16	10	8·5	4·5	—	—	—	136	,, ,, ♀ L.
—	—	—	—	—	1	3	3	2	10	4	4	—	—	—	—	—	27	Klaatsch's "Europeans"

Our four series give for the means:

♂ R. + ·444 ± ·113 ♂ L. – ·135 ± ·111

♀ R. + ·551 ± ·135 ♀ L. + ·287 ± ·136.

It will be seen that actually our male left femora give an insignificant *negative* value while the female left series is scarcely significant. The right series for both sexes give significant but very small values about half a millimetre. Klaatsch's small series gives + ·667 ± ·216[2], a value considering its probable error quite in keeping with ours. It does not seem reasonable to suppose that this ½ mm. in natural length would be appreciated by the unaided eye. It is to be noted that the modal value for both male series is *zero* difference. The female series being short show some irregularity, but the true modes cannot be far from zero. Now out of our 626 femora 286 gave a *negative* difference or 46 °/₀. In Klaatsch's short series 30 °/₀ had a larger mesial condyle and in Bumüller's series in 30 °/₀ of cases there was equality or excess of the mesial condylar length. In view of this we conclude as against Klaatsch that it is not possible on the basis of the – 1·8 difference in condyle lengths to assert that the Trinil femur is pithecoid in character. A difference greater than – 1·5 occurs in more than 21 °/₀ of our femora and therefore cannot be considered as demonstrating pithecoid character in an isolated individual. Negative racial *means* would, however, signify *pro tanto* in human data an approach to pithecoid character, although no stress can be laid on a negative value in an isolated individual.

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[1] The only data we know on this point are the few provided by Zanolli, who gives the index 100 × *Diam. trasv. cond. interno/Diam. trasv. cond. laterale* = presumably the ratio of *breadth* of internal to that of external condyle as 93·8 for 20 ♂ and 96·0 for 23 ♀ Bolognese, and possibly Klaatsch's somewhat mysterious "Condylen lat. Diam. longitudinalis" and "Condylen med. Diam. longitudinalis" of the Aurignac (R. 31, L. ?, R. 34, L. 35) and Neanderthal (R. 37, R. 42) femora respectively. (Bibl. 103$^{\text{bis}}$, S. 329, Tabelle 8.)

[2] It is possible that this represents the difference of *oblique* lengths, in which case the agreement would not be so close. Bumüller gives for 27 ♂s, presumably Bavarians, a difference of 2 mm. in the natural lengths and states that in four there was equality and in four excess of mesial condyle. He further gives 3·25 mm. as the difference in the projected or oblique condyle lengths of 12 femora, the range being from + 1 to + 6. Both these series are too short to be of any real value. We find for 73 ♂s a difference of + 4·30 and for 62 ♀s one of + 3·55, which indicate that the difference of the oblique lengths is very much greater than that of the natural lengths.

The table on p. 404 gives the absolute values we have been able to collect and they are summarised below.

Summary for Lengths of Condyles.

	Maximum Length		Oblique Length		Difference of Lengths	
	Lateral	Mesial	Lateral	Mesial	Maximum	Oblique
Lemuroids	13·28	12·73	12·21	11·85	+ ·38	+ ·36
Cebidae	14·74	14·91	14·08	13·86	– ·17	+ ·19
Simiadae	24·96	25·36	24·14	23·65	– ·20	+ ·49
Dryopithecus rhenanus ...	31·0	30·0	29·2	28·6	+ 1·00	+ ·60
Gibbon	18·1	19·4	17·67	17·73	– 1·3	– ·17
Ateles	24·1	25·25	23·6	23·5	– 1·15	– ·10
Greater Anthropoids	42·67	51·80	41·65	46·18	– 9·13	– 4·53
Neanderthal Type	72·5	66·7	71·1	66·7	+ 5·8	+ 4·4
17th century Londoners ♂ + ♀	59·28	58·81	58·46	54·20	+ ·28	+ 3·92

It is clear from the longer table that for Lemuroids and lesser apes the differences of the condyle lengths, whether maximum or oblique, are small and by no means of the same sign in the same family, still less so within the genus or species. On the whole the difference of oblique lengths is generally positive, but exception occurs in all the *Simiinae*, where not only the difference of the oblique lengths but of the maximum lengths also is negative and considerable. *Dryopithecus rhenanus* is an exception in our measurement, but not in Klaatsch's, and is thus out of the accordance it usually has with the Gibbon and *Ateles*. The sudden appearance of large negative values in the Greater Anthropoids seems to be beyond question and is somewhat startling when compared with large positive values in the Neanderthal Type. The large positive difference appears to be retained in Recent Man for the oblique lengths, but falls to a very small quantity in the case of the maximum lengths. Unfortunately we have no values for the Cromagnon Type or the Grimaldi Type to throw light on the transition from Neanderthal Type to Recent Man. It is clear from the longer table and what goes before that although individual genera may have excess of the maximum length of the lateral condyle, yet in a broad way Bumüller's statement is correct, if it is merely a statement of averages. On the average the lesser apes and anthropoids have a longer mesial than lateral condyle and this position is reversed in both Primogenial and Recent Man. Recent Man, however, for maximum length of condyles appears to have regressed on Primogenial Man and to stand between him and the apes. This is a position we so often find occurring, and should cause those to pause, who sum up Neanderthal Man as being more "gorilloid" than Recent Man. He is, but only in a very limited number of characters.

Probably it will already have occurred to the reader that while the *sign* of this difference is interesting its absolute value is of small weight, because femora of larger build will essentially have a larger condyle difference. The difference therefore needs

TABLE XLVII. *Table of Maximum and Oblique Condylar Lengths.*

	Race *	Maximum Length		Oblique Length		Δ_1	Δ_2	Authority
		a Lateral Condyle	*b* Mesial Condyle	*c* Lateral Condyle	*d* Mesial Condyle	*a* − *b*	*c* − *d*	
Lemuroids	*Tarsiidae* (2)	8·25	8·3	7·55	7·7	− ·05	− ·15	Pearson and Bell
	Lorisinae (6)	8·3	9·5	7·85	8·5	− 1·20	− ·65	,,
	Galaginae (6)	9·2	9·0	8·2	7·75	+ ·20	+ ·45	,,
	Chiromyrdae (2)	16·5	15·3	15·05	14·75	+ 1·20	+ ·30	,,
	Lemurinae (18)	18·2	17·0	16·6	15·7	+ 1·20	+ ·90	,,
	Indrisinae (8)	19·2	17·25	18·0	16·7	+ ·95	+ 1·30	,,
		Mean 13·28	Mean 12·73	Mean 12·21	Mean 11·85	Mean + ·38	Mean + ·36	
Cebidae	*Hapalinae* (16)	8·65	8·2	7·9	7·6	+ ·45	+ ·30	Pearson and Bell
	Nyctipithecinae (8)	11·0	10·9	10·3	10·1	+ ·10	+ ·20	,,
	Pithecia (2)	13·1	12·9	12·7	12·2	+ ·20	+ ·50	,,
	Lagothrix (2)	13·1	13·45	12·55	12·45	− ·35	+ ·10	,,
	Cebus (6)	13·6	14·1	13·0	13·05	− ·50	− ·05	,,
	Brachyurus (2)	15·6	15·05	14·8	14·35	+ ·55	+ ·45	,,
	Mycetes (2)	18·75	19·4	17·75	17·65	− ·65	+ ·10	,,
	Ateles (4)	24·1	25·25	23·6	23·5	− 1·15	− ·10	,,
		Mean 14·74	Mean 14·91	Mean 14·08	Mean 13·86	Mean − ·17	Mean + ·19	
Simiadae	*Cercopithecus* (8)	19·5	19·7	18·9	18·7	− ·20	+ ·20	Pearson and Bell
	Macacus (14)	23·7	24·7	23·1	22·9	− 1·00	+ ·20	,,
	Semnopithecus (10)	24·9	24·1	23·4	22·4	+ ·80	+ 1·00	,,
	Cercocebus (4)	26·15	26·4	25·0	24·65	− ·25	+ ·35	,,
	Cynocephalus (8)	30·55	31·9	30·3	29·6	− ·35	+ ·70	,,
		Mean 24·96	Mean 25·36	Mean 24·14	Mean 23·65	Mean − ·20	Mean + ·49	
	Dryopithecus rhenanus	31·0 (1)	30·0 (1)	29·2 (1)	28·6 (1)	+ 1·00	+ ·60	From cast
	The following results from other authors more or less confirm our values above.							
	Lemur catta (1)	17·0	16·0	—	—	+ 1·0	—	Klaatsch *
	Alonata geniculus (2)	17·7	19·2	—	—	− 1·5	—	Hrdlička †
	Cebus capuchinus (1)	15·0	14·5	—	—	+ 0·5	—	Klaatsch
	Cebus hypoleucus (1)	16·5	18·0	—	—	− 1·5	—	Hrdlička
	Mycetes (1)	26·0	29·0	—	—	− 3·0	—	Klaatsch
	Ateles (1)	19·0	20·0	—	—	− 1·0	—	,,
	Cynocephalus anubis (1)	37·0	39·1	—	—	− 2·0	—	,,
	Cynocephalus porcarius (1) ...	31·0	33·1	—	—	− 2·0	—	Hrdlička
	Dryopithecus rhenanus (1)	29·0	30·0	—	—	− 1·00 (!)	—	Klaatsch

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* It is possible that all Klaatsch's values in this table are for the *oblique* condylar lengths, although he speaks of the "maximum diameter." His results for the Neanderthal and Spy femora would then agree better with ours on the casts. But Klaatsch scorned biometric methods and never read to a fraction of a millimetre, so that one can never be very certain of his measurements.

† We have inserted Hrdlička's measurements in this table of "Maximum Antero-posterior Diameters of Inner and Outer Condyles," but as in the case of Klaatsch cannot be sure it is not the projective or oblique length that he is measuring. This doubt is emphasised by the fact that he also gives a "Maximum Antero-posterior Diameter of the Lower Extremity of the Femur." This in the *Tetraprothomo* is of the same size as the "Max. Diameter Ant. Post. of the inner Condyle"; such is also the case in the femora of a Jaguar and an Ocelot, while in that of a Puma it is even greater. On the other hand in all the apes it is less. Hrdlička gives the like measurements on the femur of a white man 59·5, 62·0 with a difference − 2·5—a striking instance of the danger of taking a single instance to provide a type! We have not thought it needful to include this isolated human case in the table. *Tetraprothomo* refers to the fossil catlike femur found on Monte Hermosa whose owner, Ameghino suggests, was a direct ancestor of man. For Hrdlička, see "Skeletal Remains of Early Man," *Smithsonian Institute*, *Bulletin of Bureau of American Eth-*

	Hylobates lar (1)	18·3	19·9	17·8	18·0	− 1·6	− ·20	Pearson and Bell
	,, *mulleri* (2)	18·0	19·15	17·45	17·6	− 1·15	− ·15	,,
	,, *syndactylis* (1)	32·0	36·0	—	—	− 4·0	—	Klaatsch
	,, ? (1)	20·5	22·0	—	—	− 1·5	—	Hrdlička †
Simiinae	Orang-utan (5)	33·4	41·2	33·0	35·8	− 7·8	− 2·8	Pearson and Bell
	,, (1)	45·0	57·0	—	—	− 12·0	—	Hrdlička
	,, (1)	—	—	—	—	− 12·0	—	Bumüller
	Chimpanzee (2)	43·4	51·5	41·45	45·45	− 8·1	− 4·0	Pearson and Bell
	,, (1)	41·0	52·0	—	—	− 15·0	—	Klaatsch
	,, (1)	43·0	48·0	—	—	− 5·0	—	Hrdlička
	Gorilla (7)	51·2	62·7	50·5	57·3	− 11·5	− 6·8	Pearson and Bell
	,, (3)	43·7	56·7	—	—	− 13·0	—	Klaatsch
	,, (1)	42·0	51·0	—	—	− 9·0	—	Hrdlička
	Pithecanthropus erectus	62·2	64·0	62·0?	61·0?	− 1·8	+ 1·0?	Photographs
	Tetraprothomo (Ameghino) (1) ...	34·0	38·0	—	—	− 4·0	—	Hrdlička †
Primogenial Man	Neanderthal Type (6)	72·5	66·7	71·1	66·7	+ 5·8	+ 4·4	Various
	Homo mousteriensis (*Hauseri*) (1)	70·4?	60·0?	68·0?	—	+ 10·4?	—	From cast
	La Chapelle-aux-Saints (1) ...	[70·7] ‡	64·0?	—	—	+ 6·7?	—	Photographs
	Neanderthal L.	75 2	69·5	74·2	—	+ 5·7	—	From cast
	,, ,, ...	71·0	66·0	—	—	+ 5·0	—	Klaatsch
	,, R.	70·0	67·0	—	—	+ 3·0	—	,,
	Spy I R.	73·7	69·1	72·2§	—	+ 4·6	—	From cast
	,, ,, ...	72·0	67·0	—	—	+ 5·0	—	Klaatsch
	Galley Hill	> 64·0	—	> 60·9 ‖	—	—	—	From cast
Recent Man	Badenser (27)	61·00	60·33	—	—	+ ·67	—	Klaatsch
	17th century Londoners ...	♂ 62·44 (389)	62·06 (418)	61·45 (416)	56·12 (73)	+ ·15 (362)	+ 4·30 (73)	Pearson and Bell
	,, ,, ...	♀ 56·12 (283)	55·56 (315)	55·48 (299)	52·29 (62)	+ ·42 (264)	+ 3·55 (62)	,,
	Bavarian Males	—	—	—	—	+ 2·00 (12)	+ 3·25 (27)	Bumüller
	Fuegians (10)	—	—	62·4	—	—	—	Hultkrantz
	Australians (4)	♂ 65·95	66·3	65·35	60·85	− 0·35	+ 4·50	Pearson and Bell
		♀ 57·85	57·7	57·15	54·25	+ 0·15	+ 2·90	
	Gilbert Islander (1)	65·0	63·0	—	—	+ 2·0	—	Klaatsch
	Malay (1)	59·0	58·0	—	—	+ 1·0	—	,,
	Javanese (1)	58·0	55·0	—	—	+ 3·0	—	,,
	Negrito (1)	53·0	53·0	—	—	0·0	—	,,
	Negroes ♂	61·9	59·3	61·5	—	+ 2·6	—	Various
	,, ♀	56·2	53·1	55·5	—	+ 3·1	—	,,

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nology, 1912, pp. 380—3, and for Ameghino, Bibl. 100ter. In all the genera dealt with by Hrdlička including man he finds the antero-posterior maximum length of the mesial condyle *greater* than that of the lateral condyle (*l c.* p. 383). He does not appear to have noticed that European femoralogists had asserted previously that this relation of the condyles was actually a criterion for distinguishing the pithecoid from the human.

‡ Reconstructed value and therefore doubtful.

§ Fraipont and Lohest give the "antero-posterior diameter of the condyle" as 55 in Spy No. 1 (Bibl. 42bis, S. 651—6). This is wholly out of keeping with the cast or with Klaatsch's statement of values.

‖ Newton (Bibl. 69bis, p. 508) says "length of condyles" is 62. It is not clear what is meant by "length of condyles" and the cast suggests that the bone is too defective to measure any condylar length. But then this author holds it sufficiently definite to state of the Galley Hill femur that "the long axes of these two portions [shaft and neck] seem to be at the usual angle with each other"! (p. 509).

to be divided by a quantity measuring the size of the bone and we not unnaturally take the maximum length of the mesial condyle itself. But this leads us directly to the consideration of whether the Condylar Lengths Index is in excess or defect of 100. A study of this index, however, will be found not to upset the very broad generalisations we have drawn from the crude differences.

(v) *Condylar Lengths Indices.*

This important index we take to be 100 × natural length of lateral condyle/natural length of mesial condyle. A similar index may be formed of the projective or oblique lengths and with several authors we cannot by any means be certain which lengths they have measured. The differences of the indices are not so considerable as might be supposed as both lengths are reduced. Still they are not reduced proportionately, and this while possibly not affecting the main features will certainly modify the minor details of the generic or racial order. At present the matter is not of such great importance as we have only slender data for the races of Recent Man, but it may be hoped that femoralogists in supplying this immediate need will take if possible both indices, or, if one only, will base their observations on the natural condylar lengths.

The following tables contain all the data we have thus far been able to collect.

The first table gives our results for the Condylar Lengths Index (*Oblique* Lengths) of the Primates.

TABLE XLVIII. *Condylar Lengths Index* (Oblique or Projected Lengths).

Lemuroidea		*Lorisinae* (6)	92·34	Mean 95·19	Mean 101·96
		Tarsiidae (2)	98·05		
		Chiromyrdae (2)	102·03	Mean 105·34	
		Lemurinae (18)	105·73		
		Galaginae (6)	105·81		
		Indrisinae (8)	107·78		
Cebidae		*Cebus* (6)	99·62		Mean 101·82
		Ateles (4)	100·43		
		Mycetes (2)	100·57		
		Lagothrix (2)	100·80		
		Nyctipithecinae (8)	101·98		
		Brachyurus (2)	103·14		
		Hapalinae (16)	103·95		
		Pithecia (2)	104·10		
Simiadae		*Macacus* (14)	100·87		Mean 102·04
		Cercopithecus (8)	101·07		
		Cercocebus (4)	101·42		
		Cynocephalus (8)	102·36		
		Semnopithecus (10)	104·46		
Simiinae	Hylobates	*Dryopithecus rhenanus* (1)	102·10		
		Recent Gibbon (2)	99·15		
		[*Ateles* (4) (for comparison)	100·43]		
	Greater Anthropoids	Gorilla	♂ 87·31 (4), ♀ 89·42 (3) ♂ + ♀ 88·21 (7)		Mean 90·53
		Chimpanzee (2)	91·20		
		Orang-utan (5)	92·18		
		Pithecanthropus erectus (1)	101·6 ?		
Hominidae		Primogenial Man, Neanderthal Type	106·6		
		Recent Man (17th century Londoners)	♂ 107·66 (73) ♀ 106·79 (62)		
		Recent Man (17th century Londoners)	♂ + ♀ 107·26 (135)		
		Australians	♂ 107·4 (2) ♀ 105·3 (2)		

TABLE XLIX. *Condylar Lengths Index* (Natural or Maximum Lengths).

	Group	Value of Index		Source of Material
Lemuroids	*Lorisinae* (6)	86·9	Mean 102·65	Pearson and Bell
	Tarsiidae (2)	99·4		,,
	Galaginae (6)	103·5		,,
	Lemurinae (18)	106·8		,,
	Chiromyrdae (2)	107·9		,,
	Indrisinae (6)	111·4		,,
Cebidae	*Ateles* (4)	95·5	Mean 99·77	Pearson and Bell
	Cebus (6)	96·6		,,
	Mycetes (2)	96·65		,,
	Lagothrix (2)	97·4		,,
	Nyctipithecinae (8)	101·1		,,
	Pithecia (2)	101·55		,,
	Brachyurus (2)	103·65		,,
	Hapalinae (16)	105·7		,,
Simiadae	*Macacus* (14)	96·0	Mean 98·87	Pearson and Bell
	Cynocephalus (8)	97·2		,,
	Cercocebus (4)	99·05		,,
	Cercopithecus (8)	99·2		,,
	Semnopithecus (10)	102·9		,,
	Lemuroidea (4)	111·16		Collected from various authorities for comparison with above
	"New World Monkeys" (5)	91·89	95·38	
	Platyrrhini (5)	98·88		
	Cercopithecidae (10)	98·21		
	Dryopithecus rhenanus (1)	105·3		Cast
	,, ,,	96·7		Klaatsch
	Pithecanthropus erectus	97·2?		From photographs

	Group	Value of Index		Source of Material
Simiinae	Orang-utan (5)	81·2	Mean P. & B. 82·40 ,, Rest 82·12	Pearson and Bell
	,, (6)	80·65		Various authors
	Gorilla (7)	81·8		Pearson and Bell
	,, (8)	83·53		Various authors
	Chimpanzee (2)	84·2		Pearson and Bell
	,, (4)	82·18		Various authors
	Gibbon (2)	94·1		Pearson and Bell
	,, (5)	91·34		Various authors
Mammals	*Ursus americanus* (1)	79·55		Hrdlička
	Tetraprothomo (Ameghino) (1)	89·47	Mean 95·59	,,
	Hyena striata	94·16		,,
	Modern N. American *Canidae*	95·32		,,
	Ancient N. American *Canidae*	95·32		,,
	Modern S. American *Felidae*	99·30		,,
	Ancient N. American *Felidae*	100·00		,,
Recent Man	Australians	♂ 99·5 (2) ♀ 100·2 (2)		Pearson and Bell
	Negrito (1)	100·0		Klaatsch
	17th century Londoners	♂ 100·34 (356) ♀ 100·80 (259)		Pearson and Bell
	Badenser (27)	101·11		Klaatsch
	Modern Bolognese	♂ 101·01 (20) ♀ 101·42 (23)		Zanolli
	Malay (1)	101·7		Klaatsch
	Bavarians (27)	103·0 (?♂)		Bumüller
	Gilbert Islander (1)	103·2		Klaatsch
	Javanese (1)	105·5		,,
Primogenial Man	Spy (1)	106·7	Mean 110·7	From cast
	Neanderthal (1)	108·2		,,
	La Chapelle-aux-Saints (1)	110·5?		From photographs
	Homo mousteriensis (*Hauseri*)	117·3??		From cast

We summarise as below:

Condylar Lengths Indices.

	Maximum Lengths	Oblique Lengths
Lemuroids	102·65	101·96
Cebidae	99·77	101·82
Simiadae	98·87	102·04
Dryopithecus rhenanus ...	105·3	102·10
Gibbon	94·1	99·15
Ateles	95·5	100·43
Greater Anthropoids	81·9	90·53
Neanderthal Type	110·7	106·6
Recent Man (17th century Londoners) ...	100·53	107·3

Now this summary is very suggestive, the ratio of maximum condylar lengths falls continuously from Lemuroids to Greater Anthropoids. There is hardly any change in the oblique lengths from Lemuroids to lesser apes and even to the gibbon, but a sudden fall occurs at the Greater Anthropoids. This is followed by a correspondingly great rise in Primogenial Man, a rise maintained for the oblique lengths, but not for the maximum lengths, in the case of Recent Man. Neanderthal Man is much closer to Recent Man than to any Recent Anthropoids, and he appears to be the very reverse of "gorilloid" or even "orangoid" in the ratio of his condylar lengths. The fossil gibbon, however, suggests that the tendency to exaggerate the mesial at the expense of the lateral condyle is relatively recent in the *Simiinae* even in the gibbon, and that if we could find fossil femora of the Greater Anthropoids, their condylar indices would be more like those of the Eppelsheimer femur and so more human. In other words that as far as this character of the distal epiphysis goes, man is more primitive than the modern *Simiinae, i.e.* he approximates more to the lesser apes. Indeed an examination of the complete tables indicates that in none of the great primate families have genera ever been wanting with their condylar indices far removed from those of Recent Man—the reader has only to look at both indices for *Semnopithecus*, *Hapalinae* and the true Lemurs. What is wanting is an explanation of why Man is like these particular genera of the lesser apes rather than like recent anthropoids. It can hardly be uprightness of gait which for this character separates man from the gorilla in the same way as *Semnopithecus* is separated from *Macacus*, the *Hapalinae* from *Ateles* or *Cebus* and the *Indrisinae* from the *Lorisinae*. Some feature of muscular development, some characteristic use of the knee-joint in posture or progression, ought to associate the *Indrisinae*, *Hapalinae*, *Semnopithecus* and Man, and differentiate them from the *Lorisinae*, *Cebus*, *Macacus* and the *Simiinae*. In what respect do these groups fill supplementary places in nature?

We have included in the first of the above tables the few individual femora for which Klaatsch provides data and this for two purposes, (i) to indicate the absolute idleness of publishing measurements on single individuals. We are quite certain that when a complete racial table for the Condylar Lengths Index in Recent Man has been obtained racial differentiation will be found between the Bavarians and Gilbert Islanders and between the Malays and the Italians; (ii) to indicate on the basis of the very slender material yet available that the big genera in our table are as far as we are able to judge differentiated in their *means*. The table in itself is extraordinarily suggestive, the order of increasing value of index being Anthropoids, Monkeys, Recent Man, Primogenial Man of the Neanderthal Type. The monkeys in this characteristic—equality of condyles—are nearer to man than the anthropoids or Primogenial Man. Whereas in Recent Man and the Monkeys, there is an approach to equality, the anthropoids show marked excess of the mesial condyle and the Neanderthal marked defect of the mesial condyle relative to the lateral condyle. In other words Primogenial Man is in this—as in a good many other respects—farther removed than Recent Man from the Lesser Apes. It is again as if, in the Neanderthal Type, a favourable variation had been overdone and Recent Man had had to return to a lower value closer to that of the Lesser Apes. One would certainly in the state of our present knowledge like to think of the Neanderthal Type as a gorilloid version of man, which had failed from the evolutionary standpoint. But there are so many features of the Neanderthal Type femur in which it differs more than Recent Man from the larger Anthropoids, that one is compelled to believe that the description of the Neanderthal Type as a gorilloid type of man is due principally to its general massiveness in appearance, supported by a few characters like the absence of a pilaster, the high Index of Robusticity and the absolute size of Head, but does not depend on a more minute quantitative study of the relative proportions of the parts. In a considerable number of relative characters it will be found that the average femur of the *Simiadae* is closer than that of the orang to the femur of Recent Man, and fascinating as is Klaatsch's suggestion[1]—based principally, we fear, on visual appearance—of an orangoid origin for Recent Man and a gorilloid origin for Primogenial Man of the Neanderthal Type, we do not think it will stand a more minute investigation of femoral characters. The fundamental point in the discussion of the present character is the drawing together in the centre of Recent Man and the Lesser Apes, and the appearance on *opposite* flanks of Primogenial Man and the Recent Anthropoids. Those flanks were probably relative failures because they were opposite extremes. Do we suggest then that man has descended from a Lesser Ape form without passing through an anthropoid stage? On the contrary we hold that the protsimio-human was a troglodyte in form of femur, but that for this character he was, like *Dryopithecus rhenanus*, much more human than recent anthropoids, and this because he was approaching more closely to the branch point of the *Simiadae*. It is confirmatory of this interpretation that Recent Man so frequently *appears* to have reverted to the Lesser Apes. It only signifies that in some characters he is more primitive than Recent Anthropoids, by which we mean more like the common ancestor—the troglodyte[2] who would naturally be nearer than they are to the branch point of the *Simiadae*. Of course some stress is here laid on the position taken by *Dryopithecus rhenanus* which indicates a "converging value" for the Condylar Lengths Index of the *Simiinae*. We are, however, depressed by the fact that Bumüller gives 96·7 instead of our 105·3[1].

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[1] Bibl. 102ter, S. 91—99 and Bibl. 102bis, S. 513—577.

[2] The sense in which we use troglodyte for a *primitive* Chimpanzee-like femur will be more fully elucidated in the following chapter.

The reader will notice that in our table we have included certain interesting results for the mammals due to Hrdlička. These values seem to justify that writer's opinion that the Monte Hermosa femur, which has been entitled *Tetraprothomo* by Ameghino and is looked upon by him as something of the nature of a protsimio-human, is probably the bone of one of the fossil American *Felidae*. The mean of Hrdlička's *Canidae* and *Felidae* group is 95·59, which is somewhat above the *Tetraprothomo* femur (89·5). That value, however, is flanked by Hrdlička's single specimen of the *Ursidae* (79·6) and these values are all much below that of the average Lemuroid and those of the Lesser Apes. On the other hand while not corresponding to any of the recent Greater Anthropoids, it has an approximation to a gibbon-like value. Unfortunately this fossil femur is not in the least like a gibbon's, and if it were we have every reason to believe that fossil gibbons had a very

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[1] We indicate elsewhere that the cast of the *Dryopithecus rhenanus* is not wholly reliable for exact measurements. Beyond Klaatsch's measurements of the condylar lengths of the Eppelsheimer femur and some few values provided by Bumüller we have not succeeded in finding any recent descriptions or data for this most important find. We have only Pohlig's papers of 1890, 1891 and 1895 (Bibl. 49$^{\text{bis}}$, S. 107, Bibl. 49$^{\text{bis}}$, second title S. 41 and Bibl. 68$^{\text{ter}}$, S. 149). His account is wholly descriptive. In the first paper he promises "eine genaue Abbildung." In the second paper we have a rough drawing of the proximal end of the femur only, the dimensions of which drawing are about 0·75″ × 0·6″, which Pohlig describes as "Beigabe der ersten richtigen Abbildung"—and gives no reference to Kaup's Plate, who at least gives the whole femur, although he reverses it! Even the scale of Pohlig's rough drawing is not provided, so that no absolute measurements can be made upon it. We made on the drawing a few index determinations, etc. which we give below accompanied by the measurements given by Bumüller (B) and Klaatsch (K) and in square brackets our own values from the cast.

Collar Angle	122°	[125°·5]
100 × Vertical Diameter of Head/Capito-Collar Length	56·9	[55·4]
100 × Length of Neck$^{(1)}$/Capito-Collar Length	66·3	[72·3]
100 × Length of Neck$^{(2)}$/Capito-Collar Length	56·9	[?]
(Length of Neck from base of Head to $^{(1)}$ Coaxial Point, $^{(2)}$ Spiral Line.)		
100 × Vertical Diameter of Neck/Vertical Diameter of Head	73·3	[70·0]
100 × Vertical Diameter of Neck/Length of Neck$^{(1)}$	62·9	[53·5]
100 × Pilastric Circumference/Diaphysial Length (B)	22·3	[?]
Pilastric Index (B)	100	[98·3]
Popliteal Index (B)	65·4	[63·5]
Index of Distal Taper (B)	94·4	[89·9]
Index of Gracility (Lower) (B)	69·3	[69·4]
Maximum Length Lateral Condyle (K)	29·0	[31·0]
,, ,, Mesial Condyle (K)	30·0	[30·0]
Condylar Lengths Index (K)	96·7	[103·3]
Condylar Index ((B) says same as that of Gibbon)	72·9	[75·4]
Bicondylar Width (deduced from (B))	39·8	[41·1]

Such appears to be the result of the "erste richtige Abbildung" and what German science has done for this most important bone! And yet some English investigators appear to have a slavish admiration for the products of German research!

much higher Condylar Lengths Index, approaching the higher values of the existing *Cebidae*. Of course the *Tetraprothomo* value falls only a little short of what we might expect in a fossil ancestor of the Greater Anthropoids, but apart from the fact that traces of these Anthropoids, fossil or recent, are lacking in America, the Monte Hermosa femur is by no means the type of femur our present investigation leads us with some plausibility to suggest for the protsimio-human—*it is not human enough*[1]. We discard therefore Ameghino's suggestion of a prot-homo in the New World, and shall believe that America did not get much further than the *Cebidae* in the upward ascent of the primates, until much more human (or anthropoid) links are found there than the Monte Hermosa femur.

The position of *Pithecanthropus erectus* in the Condylar Lengths Index may be largely due to its queried value. Bumüller gives only "91 to 94," sufficiently in accordance with our independent determination under the circumstances. Thus placed it stands in Condylar Lengths Index close either to our own gibbon results, or to the average of five other gibbons, but we would remark still within the human range, and inside the not very improbable human range[2]. At any rate the point, such as it is, is only very slightly in favour of Bumüller's view of the Trinil femur as that of a new species of gibbon—*Hylobates giganteus*—and of Klaatsch's argument from the condyles of its pithecoid and non-human character. But to emphasise the few *slight* pithecoid at the expense of the many *average* human characters of the Trinil femur is to overlook the fact that most human femora differ from the mean human femur and will show in a few characters deviations considerably greater than those found for a few characters in *Pithecanthropus erectus*. If, say 100 characters are taken on any single bone, then we should expect at least two of them to depart from type by twice the standard deviation of the character, and this is precisely what occurs in the present case. We must add to this that these slight deviations from human type are gibbonwards and not troglodytic as we should anticipate personally in any protsimio-human.

(vi) *The Condylar Indices.*

The Condylar Index = 100 × Maximum Length of External Condyle/Bicondylar Width is taken as a natural measure of the relation of the sagittal to the transverse dimensions of the distal epiphysis. The maximum length is of course not truly sagittal and in this respect it might be better to take the projective length which is the value taken by Bumüller. We can give both for our material. We will term them Primary and Secondary Condylar Indices and give both where possible, although in the case of some authorities it is, as we have seen, difficult to say whether they have measured the natural or the projective length.

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[1] Compare the results reached in our Chapter X.

[2] The range in man is from 86 to 114 and 19 °/₀ are as divergent in Condylar Lengths Index as the Trinil femur.

TABLE L. *Primary and Secondary Condylar Indices.*

Group		Primary Index		Secondary Index		Source of Material
Lemuroidea	*Lorisinae* (6)	68·7	Mean 99·10	65·4	Mean 91·48	Pearson and Bell
	Chiromyrdae (2)	88·7		80·9		,,
	Lemurinae (18)	103·0		93·8		,,
	Galaginae (6)	104·3		96·5		,,
	Indrisinae (8)	110·3		102·9		,,
	Tarsiidae (2)	119·6		109·4		,,
Cebidae	*Lagothrix* (2)	59·55	Mean 75·49	57·0	Mean 71·73	Pearson and Bell
	Cebus (6)	71·6		68·6		,,
	Mycetes (2)	72·95		69·1		,,
	Ateles (4)	73·25		71·7		,,
	Brachyurus (2)	78·4		74·4		,,
	Pithecia (2)	77·95		75·6		,,
	Nyctipithecinae (8)	84·1		79·2		,,
	Hapalinae (16)	86·1		78·2		,,
Simiadae	*Macacus* (14)	81·7	Mean 85·15	79·7	Mean 82·31	Pearson and Bell
	Semnopithecus (10)	83·6		80·7		,,
	Cynocephalus (8)	84·8		82·8		,,
	Cercopithecus (8)	87·0		83·6		,,
	Cercocebus (4)	88·65		84·75		,,
New World Monkeys (4) ...		—		76·3		Hrdlička*
Dryopithecus rhenanus (1) ...		75·4 †		71·05		From cast
Simiinae	Gorilla (7)	60·7	Mean 63·35	59·8	Mean 61·8	Pearson and Bell
	Chimpanzee (2)	62·65		59·8		
	Orang-utan (5)	66·7		65·7		
	Gibbon (2)	74·4		69·1		
Pithecanthropus erectus (1) ...		79·7		79·5		From photographs
Recent Man	Javanese (1)	—		70·7		Klaatsch ‡
	Negrito (1)	—		75·7		,,
	Fuegians (9)	—		76·6		Hultkrantz
	Veddah (1)	—		76·9		Klaatsch
	17th century Londoners ...	♂ 78·08 (389) ♀ 79·91 (283)		♂ 77·04 (416) ♀ 79·26 (299)		Pearson and Bell
	Modern Bolognese	—		♂ 77·6 (20) ♀ 78·2 (23)		Zanolli§
	Malay (1)	—		77·6		Klaatsch
	Gilbert Islander (1)	—		78·3		,,
	Bavarians	—		♂ 78·9 (12) —		Bumüller
	Australians (4)	♂ 82·6 (2) ♀ 81·9 (2)		♂ 81·85 (2) ♀ 80·95 (2)		Pearson and Bell
Primogenial Man	Spy (1)	78·7	Mean 82·8	77·1	Mean 80·5	From cast ‖
	Neanderthal (1)	83·9		82·8		,,
	La Chapelle-aux-Saints (1) ...	[84·2?]		—		From photographs
	Homo mousteriensis (*Hauseri*) (1)	84·5?		81·6		From cast
Mammals	*Tetraprothomo* (Ameghino) (1)	—		89·5		Hrdlička
	Ancient American *Felidae* (5)	—		91·4	Mean 95·4	,,
	Ancient American *Canidae* (3)	—		93·4		,,
	Modern American *Felidae* (5)	—		96·7		,,
	Hyena striata (1)	—		100·0		,,

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* We have assumed Hrdlička to have measured the oblique length of the lateral condyle. He gives a "Breadth-depth Index of lower Extremity," but this is based on what he terms the "Maximum antero-posterior diameter of the lower extremity." This, as in the case of three out of four monkeys, can be less than the maximum antero-posterior diameter of the mesial condyle. We prefer in our ignorance of what this diameter signifies to use what we take to be his measures of the oblique length of lateral condyle and of the bicondylar width.

† Bumüller states that the Condylar Index (72 to 73) "würde mit Hylobates übereinstimmen." Bibl. 81, p. 115.

‡ With some hesitation we assume Klaatsch to have measured the oblique length.

§ Zanolli also gives the index 100 × Maximum antero-posterior diameter of Mesial Condyle/Bicondylar Width, ♂ 76·5 (20), ♀ 77·1 (23). Presumably this is the *Secondary* Index of the Mesial Condyle.

‖ From measurements given by Klaatsch, source not stated, we find Neanderthal R. 80·5, L. 81·6, Spy I 80·0. We have thought it safer, however, to retain our own measurements of the cast. Fraipont's 55 for "Diamètre antéro-postérieur du Condyle" of Spy gives us nothing in the way of an index which can be trusted.

Summary for Primary and Secondary Condylar Indices of the Primates.

		Family	Primary Index	Secondary Index
		Lemuroidea (42)	99·10	91·48
		Cebidae (42)	75·49	71·73
		Simiadae (44)	85·15	82·31
Simiinae	Hylobates	*Dryopithecus rhenanus* (1) ...	75·4	71·05
		Gibbon (2)	74·4	69·1
		[*Ateles* (4) (for comparison) ...	73·25	71·7]
		Greater Anthropoids	63·35	61·8
Hominidae		Neanderthal Type	82·8	80·5
		Recent Man (Mean 11 groups) ...	—	76·98
		,, ,, (17th century Londoners)	♂ 78·08 (389) ♀ 79·91 (283)	♂ 77·04 (416) ♀ 79·26 (299)
		,, ,, ,, ,,	♂ + ♀ 79·00	♂ + ♀ 78·15

This table is as suggestive as that found for the Condylar Lengths Index. We see again the drop from the Lemuroids, through *Simiadae* to the Greater Anthropoids, then the apparent rise to the Neanderthal Type and the slight-apeward fall in Recent Man. In the case of the New World Monkeys the fall has been greater than in the Old World Monkeys. We interpret this again as in the previous case. For these features of the distal epiphysis man is more primitive than the Greater Anthropoids. He is closer than they are, and indeed closer than the fossil or recent gibbons are to the *Simiadae.* If the fossil Chimpanzee could be found we imagine that the Primary Index would be about 83 to 84 and then we should see a continuous descent of the index from Lemuroids, to the branch point of the *Simiadae,* to Protsimio-human, to Neanderthal Man, to Recent Man. The lowness of the index in *Cebidae* and the Greater Anthropoids is *recent* and not primitive.

The reader will remark that, as judged by the Secondary Index, Hrdlička's values for *Canidae* and *Felidae*[1] place the mammals above the *Lemuroidea.* The "squareness" of the aspect of the femur in the standard horizontal plane has been replaced in the upward course of evolution by a rectangular aspect, the long axis being transverse.

That the position of the gibbons is due to the essential need of agility appears to us again confirmed by their close relation to *Ateles. Pithecanthropus erectus* falls well within the range of Recent Man and is separated from the gibbon by Recent Man.

We may make the following classes:

Hypostenobasic	below 70	Greater Anthropoids,
Stenobasic	70 to below 80	*Cebidae,* Gibbons and Recent Man,
Mesobasic	80 to below 90	*Simiadae* and Primogenial Man,
Eurybasic	90 to below 100	*Canidae* and *Felidae,*
Hypereurybasic	over 100	Certain of the *Lemuroidea.*

Both our Londoners and Zanolli's Bolognese show the male more stenobasic than the female.

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[1] It will be noted that Ameghino's *Tetraprothomo* has followed the ancient American *Felidae* to their position in this table.

(vii) *The Condylar Trochanteric Index; Condylar Femoral Length Ratios.*

We need a measure of the ratio of antero-posterior dimension of the distal epiphysis to the absolute size of the femur. We considered that the maximum length of the lateral condyles and the maximum length of the femur would have been the best measures on which to base such an index. Klaatsch, however, who had been among the first to grasp the importance of such an index selected the "length of the lateral condyle" and the trochanteric length of the bone. We can give both indices for our own data, but if we are to have any, however slender, comparative material we must use Klaatsch's form of this index. Unfortunately we cannot find that Klaatsch has adequately defined his "Kondylenlänge." If he is following Bumüller it should be the *oblique* length for the Condylar Index, and the *natural* lengths in the Condylar Lengths Index and when the discussion turns on the difference of lateral and mesial condyle lengths. In choosing our own index, we thought Klaatsch meant by "Kondylenlänge" the natural length (see our p. 401), and accordingly in our Table II, p. 116, and in our Table of Measurements of the Femora of Primogenial Man and Comparatives in Chapter X, we have provided the ratio of the natural length of the External Condyle to the Trochanteric Length. We will term this the Secondary Condylar Trochanteric Index. The Primary Trochanteric Index shall be the ratio of the Oblique Length of Lateral Condyle and the Trochanteric Length. We are not certain whether Klaatsch wants to find the Primary or the Secondary but he gives what he calls the proportion of Condyle Length to Trochanteric Length, and this in his view really consists in dividing the latter by the former. Hultkrantz tables what he calls the "Dicke des condyl. lateralis" and refers somewhat vaguely to Martin's paper on the Fuegians, Lehmann-Nitsche's paper on the long bones of the Row Graves, and Schmidt's *Anthropologische Methoden*, Leipzig, 1888, for further details of his methods of measurement. Klaatsch considers Hultkrantz's measurements identical with his own. Lastly we may take the first index suggested in this paragraph—which we believe to be the soundest—namely, that based on the ratio of Natural Length of Condyle to Maximum Femoral Length; we shall term this the Tertiary Index. This diversity of indices only indicates the crying need for standardisation in femoral measurements. On the other hand it is relatively easy to find factors which will satisfactorily reduce our indices to Klaatsch's or *vice versa* in the case of man. We take our standards from our London series which is the only series of adequate length for such a purpose. We find[1]:

$$\frac{\text{Maximum Length}}{\text{Trochanteric Length}} = 1{\cdot}0486 \,♂\, \text{R.}, = 1{\cdot}0520 \,♂\, \text{L.}, = 1{\cdot}0525 \,♀\, \text{R.}, = 1{\cdot}0508 \,♀\, \text{L.}$$

These are so closely in accord[2] that we can take their mean 1·051 as a reducing factor for an index based on the Maximum Length in order to obtain an index based on the Trochanteric Length and ·951 for an index based on the Trochanteric Length to find one based on the Maximum Length.

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[1] See Table I, p. 115.

[2] Neanderthal and Spy both give the ratio 1·0481, La Chapelle-aux-Saints 1·0474, and only *H. mousteriensis* (*Hauseri*) with a doubtful Trochanteric Length gives 1·0322. We may take it to be for Primogenial Man 1·048, which agrees to 3 in the 1000 with the value for Recent Man.

Again we have:

$$\frac{\text{Maximum Length Lateral Condyle}}{\text{Oblique Length Lateral Condyle}} = 1{\cdot}0152\ \text{♂ R.}, = 1{\cdot}0171\ \text{♂ L.},$$

$$= 1{\cdot}0109\ \text{♀ R.}, = 1{\cdot}0119\ \text{♀ L.},$$

$$= 1{\cdot}016\ \text{♂ (R. + L.)}, = 1{\cdot}011\ \text{♀ (R. + L.)}, = 1{\cdot}014\ \text{(♂ + ♀, R. + L.)}.$$

The ratios are not so nearly equal here as in the first case, but as the majority of authors do not state for the indices in question either sex or side of the femora dealt with, we must perforce be content with 1·014, or in the case of the reciprocal ·986. Thus:

$$\text{Primary Index} = \frac{100\ \text{Oblique Length of Lateral Condyle}}{\text{Trochanteric Length of Femur}}$$

$$= \text{Secondary Index} \times \left(\frac{\text{Oblique Length of Lateral Condyle}}{\text{Maximum Length of Lateral Condyle}}\right) \times \left(\frac{\text{Maximum Length of Femur}}{\text{Trochanteric Length of Femur}}\right)$$

$$= \text{Secondary Index} \times {\cdot}986 \times 1{\cdot}051 = 1{\cdot}036 \times \text{Secondary Index},$$

and

$$\text{Secondary Index} = {\cdot}965 \times \text{Primary Index}.$$

The justification for putting in the mean values of the ratios of the condyle lengths and the femoral lengths depends upon the principle illustrated in our Chapter IV, Table III, p. 121. Each ratio does not make more than a small percentage change and if we neglect the squares and products of the individual variation from these small changes, we obtain the above result on taking mean values. Thus let $\bar{I}_P$ be the mean Primary Index, $\bar{I}_S$ the mean Secondary Index, $\bar{R}_C$ the mean condyle lengths ratio, $\bar{R}_L$ the mean femoral lengths ratio; ΔI_P, ΔI_S, ΔR_C, ΔR_L the variation from the means for any individual. Then we have accurately:

$$\bar{I}_P + \Delta I_P = (\bar{I}_S + \Delta I_S)(\bar{R}_C + \Delta R_C)(\bar{R}_L + \Delta R_L)$$

$$= \bar{I}_S\,\bar{R}_C\,\bar{R}_L\left(1 + \frac{\Delta I_S}{\bar{I}_S} + \frac{\Delta R_C}{\bar{R}_C} + \frac{\Delta R_L}{\bar{R}_L} + \begin{array}{l}\text{square terms involving pro-}\\ \text{ducts of small quantities}\end{array}\right).$$

Hence summing for a series:

$$\bar{I}_P = \bar{I}_S\,\bar{R}_C\,\bar{R}_L$$

if we may neglect terms of the order of $\frac{1}{(100)^2}$ (product of coefficients of variation × corresponding coefficient of correlation) compared with unity, and such neglect is usually permissible. If we apply the formula to *an individual* instead of to a series we have:

$$\text{Primary Index} = \text{Secondary Index} \times \bar{R}_C \times \bar{R}_L \times \left(1 + \frac{\Delta R_C}{\bar{R}_C} + \frac{\Delta R_L}{\bar{R}_L} + \dots\right),$$

TABLE LI. *Condylar Femoral Length Ratios.*

	Group	Primary Index $= \frac{100\left(\text{Oblique Length lateral Condyle}\right)}{\text{Trochanteric Length}}$		Secondary Index $= \frac{100\left(\text{Maximum Length lateral Condyle}\right)}{\text{Trochanteric Length}}$		Tertiary Index $= \frac{100\left(\text{Maximum Length lateral Condyle}\right)}{\text{Maximum Femoral Length}}$		Source of ultimate data for indices
Lemuroidea	*Lorisinae* (6)	10·4	Mean 12·03	10·75	Mean 13·05	10·8	Mean 13·10	Pearson and Bell
	Indrisinae (8)	11·7		12·6		12·65		”
	Tarsiidae (2)	11·8		12·9		12·85		”
	Chiromyrdae (2)	12·2		13·35		13·2		”
	Lemurinae (18)	12·6		13·8		14·1		”
	Galaginae (6)	13·5		14·9		15·0		”
Cebidae	*Brachyurus* (2)	9·6	Mean 11·03	10·15	Mean 11·62	10·05	Mean 11·49	Pearson and Bell
	Pithecia (2)	10·0		10·25		10·1		”
	Ateles (4)	10·8		11·05		10·8		”
	Cebus (6)	10·9		11·4		11·4		”
	Lagothrix (2)	11·4		11·9		11·7		”
	Nyctipithecinae (8)	11·7		12·5		12·4		”
	Mycetes (2)	11·9		12·6		12·35		”
	Hapalinae (16)	11·9		13·1		13·1		”
Simiadae	*Cercocebus* (4)	11·2	Mean 12·40	11·7	Mean 12·82	11·9	Mean 13·01	Pearson and Bell
	Semnopithecus (10)	11·5		12·05		12·4		”
	Cynocephalus (8)	12·9		13·25		13·35		”
	Macacus (14)	13·3		13·5		13·7		”
	Cercopithecus (8)	13·1		13·6		13·7		”
	Dryopithecus rhenanus (1) ...	10·3		10·9		10·8		From cast
Simiinae	Orang-utan (5)	15·1	Mean 14·43	15·3	Mean 14·68	14·1	Mean 14·23	Pearson and Bell
	Gorilla (7)	14·9		14·8		14·8		”
	Chimpanzee (2)	13·3		13·95		13·8		”
	Gibbon (2)	9·1		9·4		9·3		”

	Group	Primary Index $= \frac{100 \left(\text{Oblique Length lateral Condyle}\right)}{\text{Trochanteric Length}}$	Secondary Index $= \frac{100 \left(\text{Maximum Length lateral Condyle}\right)}{\text{Trochanteric Length}}$	Tertiary Index $= \frac{100 \left(\text{Maximum Length lateral Condyle}\right)}{\text{Maximum Femoral Length}}$	Source of ultimate data for indices
	Pithecanthropus erectus (1) ...	14·2	14·2	13·7	Photographs
Recent Man	Negrito (1)	13·4	13·6	12·9	Klaatsch *
	Veddah (1)	13·9	14·1	13·4	,,
	Malay (1)	14·2	14·4	13·7	,,
	"Germans" (3)	14·24	14·44	13·74	,,
	Javanese (1)	14·3	14·5	13·8	,,
	17th century Londoners ...	♂ 14·43 (396) ♀ 14·26 (299)	♂ 14·67 (396) ♀ 14·48 (283)	♂ 13·96 (389) ♀ 13·71 (283)	Pearson and Bell
	Modern Bolognese	♂ 14·76 (20) ♀ 14·62 (23)	♂ 14·97 (20) ♀ 14·83 (23)	♂ 14·45 (20) ♀ 14·31 (23)	Zanolli
	Bavarians (?)	♂ 14·89 —	♂ 15·10 —	♂ 14·37 —	Bumüller
	Fuegians (10)	14·97	15·18	14·61	Hultkrantz
	Gilbert Islander (1)	15·3	15·5	14·8	Klaatsch
	Australians	♂ 15·5 (2) ♀ 15·65 (2)	♂ 15·5 (2) ♀ 15·65 (2)	♂ 14·6 (2) ♀ 14·95 (2)	Pearson and Bell
	Neanderthal (1)	17·4 †	17·7 †	16·8	From cast
	Spy (1)	17·3 ‡	17·7 ‡	17·2	,,
	Homo mousteriensis (*Hauseri*) (1)	18·3 ?	18·9 ?	18·3 ?	,,
	La Chapelle-aux-Saints (1) ...	17·0 ?	17·2 ?	16·4 ?	From photographs
	Galley Hill	> 15·1	> 15·8	> 15·1	From cast

* We have actually taken, to obtain some definiteness in this table, Klaatsch's data to give the Secondary Index. If they really give the Primary Index, they must be transferred to the first column and we shall obtain the Secondary Index fairly closely by adding 0·2 to their values and the Tertiary Index by subtracting 0·7.

† Klaatsch gives condyle length and trochanteric length of both Neanderthal femora, and they lead to R. 16·7, L. 16·7. It is doubtful whether they are for the Primary or Secondary Index.

‡ Klaatsch gives condyle length and trochanteric length of Spy leading to the index 17·6, which agrees best with our Secondary Index.

and the accuracy of the interchange is much lessened owing to the fact that we shall now be neglecting terms of the order $\frac{1}{100}$ (sum of coefficients of variation) compared with unity, and this is less permissible, causing in the work we are doing changes of perhaps 2 °/。 to 4 °/。. It is the best possible, however, under the circumstances, *i.e.* until femoralogists have realised the importance of drawing conclusions only from fairly long series[1].

The table on pp. 416–417 contains all the material bearing on the proportion of condyle to absolute femoral size that we can find.

Had we taken the Secondary Index for Londoners and deduced the Primary and Tertiary Indices from it by our reducing factors we should have found

Primary Index	Tertiary Index
♂ 14·46, ♀ 14·28,	♂ 13·96, ♀ 13·77,

reasonably satisfactory values. Of course the reduction factors for man must not be applied to the apes, although as we have indicated they seem fairly reasonable for Primogenial Man. Accordingly we do not think it of any importance which lateral condyle length and which femoral length is taken for the specification of this index. The indices do not differ much from each other and retain the same serial order. But it is essential to standardise the index, and for each osteometrician to state exactly what he has given. We believe that very little is to be gained by taking the Trochanteric Length instead of the maximum. We took it on the authority of Klaatsch but as in the cases of the Proximal and Distal Breadth Ratios have found no advantage in it. The maximum length of the condyle is easier to take than the oblique length,

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[1] We would ask the reader to remember that merely multiplying by such factors does not represent the whole work put into this table or other tables of this chapter. We have had to use all sorts of artifices to deduce the characters we need. We do not state this in order to emphasise the great labour put into these tables, but to warn the reader that in many cases he will not be able to verify our results by merely referring to the authors cited. The following instance will illustrate this and it is by no means an exceptional case. Bumüller does not give either the absolute Condyle Length or the Trochanteric Length of his Bavarian material. Nor does he give the Bicondylar Width. He does give the Maximum Femoral Length (450·16) and the Diaphysial Length (385·0). He tells us that

$$100 \times \text{Bicondylar Width/Diaphysial Length} = 21{\cdot}0\,;$$

hence we reconstructed the Bicondylar Width in *mms.* as 80·85. Further he gives the Condylar Index as 78·9; thus we have: 100 Oblique Length of Lateral Condyle/Bicondylar Width = 78·9. From this we reconstructed the Oblique Length of Lateral Condyle as 63·79. We were now able to obtain the Index: 100 × Oblique Length of Lateral Condyle/Maximum Length of Femur = 14·17. In order to get the Primary Condylar Trochanteric Index we have now to multiply by the factor 1·051; thus the value for that index for *male* Bavarians to whom the above values apply is 14·89, and the Tertiary Index will be 14·37. The reader would search in vain for such indices in Bumüller's monograph! The warning is very essential for the Tables of Racial Values issued from the Biometric Laboratory are largely reconstructed in this manner. We have recently had occasion to notice whole tables of racial craniometric values annexed from our cranial memoirs without acknowledgment. The values being cited as if the authors of the memoirs from which we took the original data had themselves provided our means or our indices. Thus we shall no doubt see quoted values of the Condylar Trochanteric Index as due to Bumüller, Zanolli, or Klaatsch, abstracted actually from our table. It is not fair to make these authors responsible for reconstructions of which they might not approve, and for which the reader will search vainly in their papers, even if it does save the inert appropriator from the trouble of reading the original memoirs.

the latter for accuracy requiring special apparatus for it cannot be effectively determined by the calipers alone. We used the osteometer board and a vertical gauge. Perhaps then it is best to recommend all femoralogists to concentrate on the Tertiary Index.

Summary of Table LI. *Condylar Femoral Length Ratios.*

Family			Primary Index	Secondary Index	Tertiary Index
		Lemuroidea (42)	12·03	13·05	13·10
		Cebidae (42)	11·03	11·62	11·49
		Simiadae (44)	12·40	12·82	13·01
Simiinae	Hylobates	*Dryopithecus rhenanus* (1) ...	10·3	10·9	10·8
		Gibbon (2)	9·1	9·4	9·3
		[*Ateles* (4) (for comparison) ...	10·8	11·05	10·8]
		Greater Anthropoids (14) ...	14·43	14·68	14·23
Hominidae		Neanderthal Type	17·5	17·9	17·2
		Recent Man (12 groups)	14·27	14·65	13 98
		Recent Man (17th century Londoners)	14·34	14·57	13·84

This table is of special interest as indicating extremely small difference between Lemuroids and *Simiadae*. The *Cebidae* fall on the Lemuroids and so does *Hylobates*, here closely mimicked by *Ateles*. The hesitation of *Simiadae* to fall in sympathy with *Cebidae* is explained by the continued rise in the Greater Anthropoids and in Man. Primogenial Man in the Neanderthal Type appears to have an exaggerated distal sagittal breadth relative to his femoral length. This apparently was corrected in Galley Hill and almost certainly in the Cromagnon Type for which we can find no single measurement of the condyles. The outstanding point is as usual what values to give to the Protsimio-human and the ancestors of the Greater Anthropoids. We expect something from 15 to 16[1], the maximum would then be reached in some ancestor of the Greater Anthropoids and in Neanderthal Man. Recent evolution would then show a falling relative condylar length in *Cebidae*, in *Hylobates*, in the recent Greater Anthropoids and in Recent Man. The fact that Recent Man is closer to the Anthropoids, particularly to the Chimpanzee, than to Neanderthal Man is not we believe an argument that he has not passed through a Neanderthal Stage—it is rather that the Neanderthal Stage for the Greater Anthropoids is at present missing. It emphasises the immense importance which would accompany the discovery of a fossil Chimpanzee.

Now what has the present table, notwithstanding its pitiably slender material, to teach us with regard to Recent Man? If we could really trust to basing any conclusion on Klaatsch's measurements of isolated individuals we should once more find modern Europeans in the centre of the human group flanked by primitive races on the one side approaching the pithecoid, as Malay, Veddah and Negrito, and on the other Primogenial Man, as in the Fuegians. It is sad beyond measure that we have no Eskimo, Aino, Moriori or other fringe races and no Negroes or North American Indians, to strengthen our table. *Pithecanthropus erectus* is absolutely "recent man" in this character and has an index sensibly the same as that of a Javanese or Malay. It may also be said that the Trinil femur falls into the ape range. If so it is gorilloid and very remote from the gibbon, but as it certainly is not gorilloid in other features we much prefer the view that in this, as in most other characters, it is Recent Man, and, what is more, Asiatic Man.

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[1] Of course there is a wide range of variation in this as in other indices, and no *single* index on a *single* bone would suffice to prove or disprove our suggestion.

Slope of the Condyles to Standard Sagittal Plane.

We will conclude this section dealing with the condylar lengths by a reference to the orientation of the condyles. We regret very much not having taken *ab initio* for the whole of our series the oblique length of the mesial condyle as well as that of the lateral condyle. The latter was taken because it had been used in the condylar index by Bumüller. The slope, however, of the mesial condyle to the standard sagittal plane is greater than that of the lateral condyle, although it appears in the primates to be less variable; it is possibly a more marked intraracial character in man than the slope of the lateral condyle and accordingly it would be better worth studying, but we have no material by which to determine this point. Owing to the desire to limit the characters studied[1] this character was rejected when planning our work. It has only been as the femur grew more and more familiar to us and we realised more fully the importance of its several characters not only as criteria for human races, but in their relationship to the like characters in other primates, that we have concluded that it would be wise in future to give more attention to certain characters we have neglected and less to others that we have spent energy on. Our excuse must be that we put too great faith in what previous writers—without much quantitative proof—had asserted to be important, and that not until we had ourselves dealt with them was it possible to realise that a better selection of characters could have been made. At any rate we consider the slope of the mesial condyle deserves a full study, when there are again men who have freedom without self-reproach to turn to problems of pure research. We were only able to measure the oblique length of the mesial contour in about $\frac{1}{5}$ of our material.

(viii) *Condylar Obliquity Index and Condylar Obliquity.*

Clearly the ratio of oblique to maximum length of condyle will measure in a rough way its slope to the standard sagittal plane. It does not measure it accurately, because while the oblique length is strictly perpendicular to the standard vertical plane, and so parallel to the standard horizontal plane, the maximum length of the condyle is not strictly but only roughly in a plane through the oblique length parallel to the standard horizontal plane and so perpendicular to the standard sagittal. Indeed much

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[1] We may remind the reader that our tables contain over 80 absolute and indicial characters, and that at least 20 to 30 others not in the tables are discussed at various points of the text. We were more than eight years over the measurements and reductions and some limitation was absolutely necessary.

TABLE LII. *Condylar Obliquity Indices and "Obliquity" of Condyles.*

	Group	Lateral Condyle				Group	Mesial Condyle			
		Condylar Obliquity Index		"Obliquity" of Lateral Condyle			Condylar Obliquity Index		"Obliquity" of Mesial Condyle	
Lemuroids	*Galaginae* (6)	89·13	Mean 91·90	26° 58′	Mean 23° 4′·3	*Galaginae* (6)	86·11	Mean 92·32	30° 33′	Mean 21° 54′·7
	Chiromyrdae (2)	91·21		24° 12′		*Lorisinae* (6)	89·47		26° 32′	
	Lemurinae (18)	91·21		24° 12′		*Lemurinae* (18)	92·35		22° 33′	
	Tarsiidae (2)	91·52		23° 46′		*Tarsiidae* (2)	92·77		21° 55′	
	Indrisinae (8)	93·75		20° 22′		*Chiromyrdae* (2)	96·41		15° 24′	
	Lorisinae (6)	94·58		18° 56′		*Indrisinae* (8)	96·81		14° 31′	
Cebidae	*Hapalinae* (16)	91·33	Mean 95·10	24° 2′	Mean 17° 40′·6	*Mycetes* (2)	90·98	Mean 93·05	24° 31′	Mean 21° 23′·6
	Nyctipithecinae (8)	93·64		20° 33′		*Cebus* (6)	92·55		22° 15′	
	Mycetes (2)	94·67		18° 47′		*Lagothrix* (2)	92·57		22° 14′	
	Brachyurus (2)	94·87		18° 26′		*Nyctipithecinae* (8)	92·66		22° 6′	
	Cebus (6)	95·59		17° 5′		*Hapalinae* (16)	92·68		22° 4′	
	Lagothrix (2)	95·80		16° 40′		*Ateles* (4)	93·07		21° 27′	
	Pithecia (2)	96·95		14° 11′		*Pithecia* (2)	94·57		18° 58′	
	Ateles (4)	97·93		11° 41′		*Brachyurus* (2)	95·35		17° 34′	
Simiadae	*Semnopithecus* (10)	93·98	Mean 96·63	19° 59′	Mean 14° 18′·6	*Cynocephalus* (8)	92·71	Mean 93·35	22° 1′	Mean 20° 59′·2
	Cercocebus (4)	95·60		17° 4′		*Macacus* (14)	92·79		21° 57′	
	Cercopithecus (8)	96·92		14° 15′		*Semnopithecus* (10)	92·95		21° 39′	
	Macacus (14)	97·47		12° 55′		*Cercocebus* (4)	93·37		20° 59′	
	Cynocephalus (8)	99·18		7° 20′		*Cercopithecus* (8)	94·92		18° 20′	
	Dryopithecus rhenanus ...	94·19		19° 38′		*Dryopithecus rhenanus*	95·33		17° 35′	
Simiinae	Chimpanzee (2)	95·51	Mean 97·44	17° 14′	Mean 12° 33′·5	Orang-utan (5)	86·89	Mean 89·61	29° 40′	Mean 26° 12′·7
	Gibbon (2)	96·94		14° 13′		Chimpanzee (2)	88·25		28° 3′	
	Gorilla (7)*	98·51		9° 54′		Gorilla (7)	91·40		23° 56′	
	Orang-utan (5)	98·80		8° 53′		Gibbon (2)	91·91		23° 12′	
	Pithecanthropus erectus (1) ...	99·68?		4° 36′?		*Pithecanthropus erectus* (1) ...	95·31?		17° 37′?	
	Galley Hill (1)	[95·16??]		[17° 54′??]		Galley Hill	—		—	
	Homo mousteriensis (*Hauseri*) (1)	96·59?	Mean 97·74	15° 0′	Mean 11° 59′	*Homo mousteriensis* (*Hauseri*) ...	—		—	
	Spy (1)	97·97		11° 35′		Spy	—		—	
	Neanderthal (1)	98·67		9° 21′		Neanderthal	—		—	
	17th century Londoners ♂ ...	98·41	Mean 98·63	10° 13′	Mean 9° 26′	17th century Londoners ♂ ...	91·97	Mean 92·74	23° 7′	Mean 22° 27′·5
	" " ♀ ...	98·86		8° 40′		" " ♀ ...	93·51		20° 45′	

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* It is noteworthy how small is the sexual difference of these indices not only in Man, but in the Gorilla, where we have ♂ 98·56 and 91·26, ♀ 98·45 and 91·59.

the same objections may be raised to this measure of the slope of the condyle as to Warren's pseudo-obliquity: see our p. 31. All we can say is that in a roughly approximate way, if we take $\cos\theta =$ oblique length of condyle/maximum length of condyle, θ will measure the slope of the condyle to the standard sagittal plane. We may term $100 \cos\theta$ the condylar obliquity index and θ itself the condylar obliquity. The following table gives our own data for the Condylar Obliquity Index and for the Obliquity of both Condyles in the primates.

Summary of Results for Condylar Obliquity.

Family	Condylar Obliquity Index		Obliquity	
	Lateral Condyle	Mesial Condyle	Lateral Condyle.	Mesial Condyle
Lemuroids (42)	91·90	92·32	23° 4′·3	21° 54′·7
Cebidae (42)	95·10	93·05	17° 40′·6	21° 23′·6
Simiadae (44)	96·63	93·35	14° 18′·6	20° 59′·2
Simiinae (16)	97·44	89·61	12° 33′·5	26° 12′·7
Dryopithecus rhenanus (1)	94·19	95·33	19° 38′	17° 35′
Recent Gibbon (2)	96·94	91·91	14° 13′	23° 12′
[*Ateles* (4) (for comparison)	97·93	93·07	11° 41′	21° 27′]
Neanderthal Man (3)	97·74	—	11° 59′	—
Recent Man (17th century Londoners)	98·63	92·74	9° 26′	22° 27′·5

Now this table shows us that the slopes to the sagittal standard plane of lateral and mesial condyles have followed different lines of evolution. Among the Lemuroids, the slope of the two condyles are almost equal; indeed in only two genera—*Galaginae* and *Lorisinae*—is the obliquity of the mesial condyle the greater. In the four remaining genera it is very considerably less. The result is that in the Lemuroids as a whole the lateral condyle has on the average a slightly greater slope than the mesial. In the *Cebidae* all but two genera—the *Hapalinae* and *Brachyurus*—have the obliquity of the mesial contour the greater, and the mean slope of the mesial condyle is substantially greater than that of the lateral condyle for the family. In the *Simiadae* no genera have the obliquity of the mesial condyle greater than that of the lateral condyle, and the difference of the mean slopes is still further increased. In the *Simiinae* in all cases the mesial condyle has the greater obliquity, and the average value is just double the slope of the lateral condyle. This development is continued in Recent Man until the slope of the mesial condyle is nearly 150 °/o above that of the lateral condyle. Looked at in broad lines the evolution is of the following character—with certain divergences to be referred to immediately—the slope of the mesial contour from the Lemuroids to man has remained right through the lesser apes about 22°, but the slope of the lateral condyle to the sagittal plane instead of retaining its mean Lemuroid value of 22° or 23° has got steadily less and less until it culminates with 9° in the *Hominidae*. In other words the balanced slope of the Lemuroid condyle has been gradually replaced in the case of the lateral condyle only by a slope which is making the plane of that condyle more and more nearly vertical.

We now turn to the divergences just referred to which are concentrated in the *Simiinae*. In the first place we note that neither the recent gibbon nor *Ateles* are for this character close to *Dryopithecus rhenanus,* although not so widely divergent from each other. *Dryopithecus* has a higher value of the slope of the lateral and a lower value of the slope of the mesial than might reasonably be anticipated. We should *à priori* have expected the fossil gibbon to have condylar obliquities nearer than the recent gibbon to the *Simiadae,* and this is certainly not the case for the lateral condyle. The second unusual phenomenon is the position of the gibbon among the *Simiinae.* It usually occupies a position well apart from the Greater Anthropoids; so far apart that we have not felt justified as a rule in including it in the *Simiinae* mean values[1]. But for the present character the index value for the lateral condyle stands between that of the chimpanzee and gorilla, and for the mesial condyle is sensibly the same as that of the gorilla itself[2]. The curious points are the approach in obliquity of the lateral condyle of the gorilla and the orang, *not* the chimpanzee, to the human value, and again the marked rise in obliquity of the mesial condyle in the case of both orang and chimpanzee. This rise is without parallel in the primates until we get back to the *Galaginae.* In this character at least Recent Man is more "gorilloid" than "orangoid," but judging by the values for Neanderthal Man and Recent Man of the obliquity of the lateral condyle, we have some reason for supposing that Neanderthal Man would tend more in the direction of orang and chimpanzee than in that of gorilla. A further study is certainly needed of why the *Simiinae* in these characters break into groups so different from the usual, and why the groups into which they split differ so much from each other, and have such a peculiar relation to the values for the *Hominidae.* Both values for *Pithecanthropus erectus* are queried values, but in slope of the lateral condyle the Trinil femur is far more nearly human than gibbon-like. In the case of the mesial condyle, that femur is within the human range, and nearer to Recent Man than to the Recent Gibbon, but nevertheless still closer, practically identical with the non-gibbon-like value for the Eppelsheimer femur.

The value for the Galley Hill femur is practically worthless; it is determined from the minimum limits to the condyle lengths. It suggests without proving that the Galley Hill femur would find its parallel rather in the Neanderthal group than in that of Recent Man.

The old fashioned evolutionary order Lemuroids, *Simiadae, Simiinae,* Primogenial Man, Recent Man receives some support from this character[3]. As an isolated instance,

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[1] This need for separation has been so great that on the basis of the femur alone, we should prefer to place the gibbon in a separate family from the Greater Anthropoids, *e.g.* the *Hylobatinae.*

[2] If we take into account the femur of a third gibbon (*Hylobates lar*) measured by us, the condylar obliquity indices for the three gibbons give 97·07 and 91·39 or obliquities of 13° 54′ and 23° 57′, thus denoting no significant change in position.

[3] The late G. Schwalbe supports (see Bibl. 94^{ter}, S. 166) the descent indicated by

Pithecanthropus erectus or as alternative | → *Pithecanthropus erectus*
↓ |
Homo primigenius | → *Homo primigenius*
(Neanderthal Type) | (Neanderthal Type)
↓ ↓
Homo sapiens *Homo sapiens*

and does not think discussion of the two of much worth. His views are of special importance, because however, it can have only limited value. At the same time the obliquity of the lateral condyle is a character very probably closely related to uprightness of gait and should be given weight proportional to this import.

(ix) *Study of the Femoral Articular Surface of the Knee-joint.*

A. *Absolute Size.* We have taken two measures of the absolute size, namely (*a*) the Width of the Distal Articulation and (*b*) the Height of the Patellar Articular Surface, which will be more briefly spoken of as Patellar Height. These two measurements are by no means very closely correlated, a great breadth of distal articulation may well be associated with a short patellar surface. For example: *Pithecia* and *Lagothrix* have almost the same patellar heights (6·7 and 6·4) but their distal articulation breadths are very unequal (15·25 and 19·95). Again, Neanderthal Man and the fossil gibbon *Dryopithecus rhenanus* have almost equal patellar heights (16·7 and 16·8) but most unequal distal articulation breadths (69·5 and 35·3). Thus neither articular measurement is in itself a standard of size and their ratio as given by the Rotular Index is a very important generic character within each family. It follows

TABLE LIII. *Absolute Value of Distal Articulation.*

	Group	Distal Articulation Width	
Lemuroids	*Tarsiidae* (2) ...	6·1	Mean 11·97
	Galaginae (6) ...	7·7	
	Lorisinae (6) ...	9·7	
	Lemurinae (18) ...	15·9	
	Chiromyrdae (2) ...	16·0	
	Indrisinae (8) ...	16·4	
Cebidae	*Hapalinae* (16) ...	9·0	Mean 17·28
	Nyctipithecinae (8)	11·6	
	Brachyurus (2) ...	12·15	
	Pithecia (2) ...	15·25	
	Cebus (6)	16·85	
	Lagothrix (2) ...	19·95	
	Mycetes (2)	22·9	
	Ateles (4)	30·5	
Simiadae	*Cercopithecus* (8) ...	20·4	Mean 26·69
	Macacus (14) ...	26·2	
	Semnopithecus (10)	26·25	
	Cercocebus (4) ...	26·4	
	Cynocephalus (8) ...	34·2	

	Group	Distal Articulation Width	
	Dryopithecus rhenanus	35·3	
Simiinae	Gibbon (2)	22·6	
	Orang-utan (5)	46·8	Mean 60·43
	Chimpanzee (2)	58·3	
	Gorilla (7)	76·2	
	Pithecanthropus erectus	73·0 ?	
Primogenial Man	Cromagnon Type (5)	82·2	
	Grimaldi Type (2)	77·8 ??	
	Neanderthal Type (6)	69·5	
	Homo aurignacensis (*Hauseri*) (1)	[64·0]	
Recent Man	17th century Londoners ♂ (73) ...	70·22*	
	,, ,, ♀ (62) ...	62·25	

* Our four Australian femora give: ♂ 72·9 (2), ♀ 65·6 (2).

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they are always backed by careful study and are not mere hypothesis. It seems to us, however, that there is important difference between the two alternatives, especially in regard to *Pithecanthropus erectus*. Our study of the Trinil femur seems to render it impossible for Neanderthal Man to be a link between *Pithecanthropus erectus* and Recent Man. But Schwalbe worked principally on the crania, and some may find adequate reason in this for separating the Trinil femur from the cranium. Be this as it may our detailed study of that femur makes it in our opinion purely that of Recent Man, and if it be that of the Protsimio-human, then neither Neanderthal Man nor indeed his branch point can well be placed between *Pithecanthropus erectus* and Recent Man.

also that their ratios to the maximum length of the femur—*i.e.* the Distal Articulation Ratio and the Rotular Ratio—are far from proportional and form indeed very marked characteristics of the primates. We can emphasise the distinctions between the genera of the primates by taking the ratio of the patellar height to the diaphysial length, this is the Rotular Diaphysial Ratio, which runs of course nearly parallel with the Rotular Ratio although with higher values[1].

Now if we place any stress on size—and vague and irregular as absolute size is we are compelled to place some stress on it—the continual increase in the distal articulation from Lemuroid to Old World Monkey, to Greater Anthropoid and then to Man is noteworthy. When we come to Man the exaggeration in the case of Cromagnon Man and the reversion of Recent Man to the Neanderthal and therefore to a more apelike value is a sequence which we have had and shall have again occasion to refer to. The Grimaldi Type value is only to be treated as an untrustworthy suggestion. As usual the Trinil femur is merely human, and *Dryopithecus rhenanus* once more indicates that the Recent Gibbon is a specialised form of a more massive femoral type. Conclusions of real value will, however, scarcely be arrived at from absolute sizes. Judging from mean values, however, for this character the *Lorisinae* are nearest to type in the Lemuroid group, *Cebus* in the *Cebidae*, *Cercocebus* in the *Simiadae*, and the Chimpanzee in the Anthropoids.

Our next table provides the corresponding data for the patellar height. The noteworthy point here is that the patellar height for the New World Monkeys is if

TABLE LIV. *Absolute Value of Patellar Surface Height.*

Group		Patellar Surface Height	
Lemuroids	*Galaginae* (6) ...	5·6	Mean 7·96
	Lorisinae (6) ...	5·6	
	Tarsiidae (2) ...	5·9	
	Chiromyrdae (2) ...	7·95	
	Indrisinae (8) ...	10·0	
	Lemurinae (18) ...	12·7	
Cebidae	*Hapalinae* (16) ...	4·7	Mean 7·71
	Nyctipithecinae (8)	5·6	
	Lagothrix (2) ...	6·4	
	Pithecia (2) ...	6·7	
	Cebus (6)	7·2	
	Mycetes (2) ...	9·6	
	Brachyurus (2) ...	9·75	
	Ateles (4)	11·75	
Simiadae	*Cercopithecus* (8) ...	10·6	Mean 13·58
	Macacus (14) ...	12·1	
	Semnopithecus (10)	13·6	
	Cynocephalus (8) ...	15·65	
	Cercocebus (4) ...	15·95	
	Dryopithecus rhenanus (1)	16·8	
Simiinae	Gibbon (2)	10·95	
	Orang (5)	19·6	Mean 22·33
	Chimpanzee (2)	22·6	
	Gorilla (7)	24·8	
	Pithecanthropus erectus (1) ...	24·0	
Primogenial Man	Cromagnon Type (5)	25·8	
	Grimaldi Type (2)	30·7??	
	Neanderthal Type (6)	16·7	
	Homo aurignacensis (*Hauseri*) (1)	[19·5]	
Recent Man	17th century Londoners ♂ (73) ...	25·81*	
	" " ♀ (62) ...	22·87	

* Our four Australian femora give: ♂ 26·65 (2), ♀ 22·75 (2).

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[1] We postpone the discussion as to the difficulties which arise in taking the distal articulation width and the patellar height to the following chapter.

anything slightly *below* that of the Lemuroids, while the Lemuroids, *Simiadae*, *Simiinae* and Man show the same continuous increase in size, and practically maintain the same relative order of genera. *Pithecanthropus erectus* is merely recent manlike, certainly not hylobatic, but Recent Man has retained the full increase of patellar surface height of the Cromagnon Type. Our value for the Neanderthal Type, based solely on photographs and casts, if correct is singularly low, approaching that of the much shorter femur from Eppelsheim. The Chimpanzee and *Cebus* remain respectively the type femora for this character of their respective families, but for the Lemuroids the Aye-Aye replaces the *Lorisinae*, and *Semnopithecus* replaces *Cercocebus* for the *Simiadae*.

More light is likely to result from a consideration of the indices.

B. *Indices.* (*a*) *Distal Articulation Ratio.* We turn first to the size of the distal articulation relative to the size of the femur, *i.e.* to the Distal Articulation Ratio. The following table indicates that the whole aspect of matters changes when we deal with relative instead of absolute size. While the *Cebidae* had not developed an absolute distal articulation as large as the *Simiadae* the mean relative size is the same for the two families, although from *Brachyurus* to *Lagothrix* the *Cebidae* provide a wider range of index values. There is a gradual ascent in index from Lemuroids to Old World Monkeys to Greater Anthropoids. But Primogenial Man has a relative articulation less than the Greater Anthropoids and standing between them and *Dryopithecus*. He is however nearest to the Recent Chimpanzee. Recent Man recedes still further from the Anthropoids much as the Gibbon has receded from its fossil predecessors. It would be not unreasonable to suggest that the Prot-simio-human—

TABLE LV. *Distal Articulation Ratio.*

Group		Distal Articulation Ratio	
Lemuroids	*Tarsiidae* (2) ...	9·5	Mean 11·81
	Indrisinae (8) ...	10·9	
	Lemurinae (18) ...	12·3	
	Lorisinae (6) ...	12·5	
	Galaginae (6) ...	12·8	
	Chiromyrdae (2) ...	12·85	
Cebidae	*Brachyurus* (2) ...	11·3	Mean 13·80
	Pithecia (2) ...	11·75	
	Nyctipithecinae (8)	13·0	
	Ateles (4)	13·65	
	Hapalinae (16) ...	13·7	
	Cebus (6)	14·1	
	Mycetes (2) ...	15·1	
	Lagothrix (2) ...	17·8	
Simiadae	*Cercocebus* (4) ...	12·0	Mean 13·84
	Semnopithecus (10)	12·9	
	Cercopithecus (8) ...	14·3	
	Cynocephalus (8) ...	14·9	
	Macacus (14) ...	15·1	
	Dryopithecus rhenanus (1)	12·3	
Simiinae	Gibbon (2)	11·75	
	Chimpanzee (2)	18·55	Mean 20·08
	Orang (5)	19·5	
	Gorilla (7)	22·2	
	Pithecanthropus erectus (1) ...	16·0?	
Primogenial Man	Neanderthal Type (6)	16·5	
	Grimaldi Type (2)	16·1??	
	Cromagnon Type (5)	15·5	
	Homo aurignacensis (*Hauseri*) (1)	[15·1]	
Recent Man	17th century Londoners ♂ (73) ...	15·76*	
	„ „ ♀ (62) ...	15·29	

* Our Australian femora give: ♂ 16·15 (2), ♀ 16·4 (2), approaching in this more the Neanderthal Type.

the ancestor of the Greater Anthropoids and Man—had a distal articulation index of 16 or 17, *i.e.* was in this attribute chimpanzee-like in character.

It is, perhaps, worth noting that no individual genus now stands very close to the family means, although we recognise fully how the addition of another species might change any generic mean, so few are the individual species in each genus that we have been able to deal with. The nearest representatives of type are: the Lemurs in the Lemuroids, *Hapalinae* in the New World Monkeys, although *Cebus* is but slightly displaced, *Cercopithecus* in the Old World Monkeys, while the Chimpanzee is only representative of type in the Anthropoids provided we take the Gibbon into account, otherwise the centre is shifted to the Orang. The positions of *Tarsius*, the Aye-Aye and *Lagothrix* suggest specialised development rather than closeness to ancestral forms, if we assume that a family has spread out in a variety of directions from an ancestral form in order to cover special phases of environment, rather than developed in a single direction.

(*b*) *Distal Articulation Index.* The next index to come under consideration is the Distal Articulation Index, *i.e.* the ratio of the breadth of the distal articulation to the breadth of the distal epiphysis. It may be taken as a rough measure of the extent to which the distal epiphysis serves as a bearing surface. In Neanderthal Man it is a relatively small portion, in the *Indrisinae, Ateles, Cynocephalus* and the Orang a relatively large portion.

TABLE LVI. *Distal Articulation Index.*

	Group	Distal Articulation Index	
Lemuroids	*Lorisinae* (6) ...	80·65	Mean 88·08
	Chiromyrdae (2) ...	86·05	
	Tarsiidae (2) ...	88·45	
	Lemurinae (18) ...	90·0	
	Galaginae (6) ...	90·1	
	Indrisinae (8) ...	93·2	
Cebidae	*Brachyurus* (2) ...	87·9	Mean 89·74
	Nyctipithecinae (8)	88·6	
	Hapalinae (16) ...	89·0	
	Cebus (6)	89·0	
	Mycetes (2)... ...	89·1	
	Lagothrix (2) ...	90·7	
	Pithecia (2) ...	90·75	
	Ateles (4)	92·9	
Simiadae	*Cercocebus* (4) ...	89·5	Mean 90·96
	Macacus (14) ...	90·5	
	Cercopithecus (8) ...	90·6	
	Semnopithecus (10)	91·0	
	Cynocephalus (8) ...	93·2	

	Group	Distal Articulation Index	
	Dryopithecus rhenanus (1)... ...	85·9	
Simiinae	Chimpanzee (2)	84·15	Mean 89·34
	Gibbon (2)	89·7	
	Gorilla (7)	90·2	
	Orang (5)	93·3	
	Pithecanthropus erectus (1) ...	93·6?	
Primogenial Man	Neanderthal Type (6)	79·4	
	Homo aurignacensis (*Hauseri*) (1)	[85·3]	
	Grimaldi Type (2)	85·6??	
	Cromagnon Type (5)	88·3	
Recent Man	17th century Londoners ♂ (73) ...	89·57*	
	" " ♀ (62) ...	88·53	

* Our Australian femora give: ♂ 91·3 (2), ♀ 92·95 (2), diverging therefore more than our Londoners from the Neanderthal Type.

Now this table is of interest because it indicates that the Distal Articulation Index has not changed more than a point since the Lemuroid stage. The Lesser Apes, both

Old World and New World, advanced perhaps two points, the Anthropoids fell back again a point and Recent Man is practically identical with the mean of the Anthropoids, 89, which is one point above the mean of the Lemuroids, or above *Tarsius* and one point less than the Lemurs. The singular constancy throughout the primates of this index is noteworthy. The only anomalous value is Man of the Neanderthal Type (79·4), which is only approached by the *Lorisinae*. We might be inclined to doubt it altogether did not the fossil Gibbon show a loss of four points on the Recent Gibbon, which suggests a possible loss of four points of the fossil Chimpanzee on the recent Chimpanzee and would bring us very nearly to 80 and the Neanderthal value for the Prot-simio-human. Even then this primate would find no parallel among recent primates except the *Lorisinae*.

The value for *Pithecanthropus* is a doubtful value and for a single bone, even so it is well within the human range (81·7—101·0) and much nearer to Recent Man than to the fossil Gibbon. Our values for Primogenial Man are undoubtedly singular, but they are admittedly precarious. Still they correspond to what we have several times had to note—an index considerably lower than the Anthropoid value rising to at least Recent Man value in Cromagnon Type femora, and thus marking a reversion to apelike values. Thus Recent Man separates the Anthropoids from Primogenial Man—a not infrequent occurrence. The significant point which should be borne in mind is that Primogenial Man is differentiated from Recent Man in the same sense as the Chimpanzee and *Dryopithecus rhenanus* from the other Anthropoids. In the case of the distal index *Tarsius* supplies the type to the Lemuroids, *Mycetes* or *Cebus* to the *Cebidae*, *Cercopithecus* to the *Simiadae* and, what is unusual, the Gibbon to the Anthropoids.

(*c*) *Rotular Ratios.* We now pass to the relative size of the patellar height, and take in one table the Rotular Ratio and the Diaphysial Rotular Ratio.

Here it will be noted that there is a regression in both indices from the Lemuroids to the Lesser Apes, although it is more marked in the New World Monkeys. Between the *Simiadae* and the *Simiinae* there is very little difference, if the Gibbon be included, although there is a distinct rise (7·6 and 9·3), if we deal only with the Greater Anthropoids. Then with Primogenial Man we have the same peculiarities as in the case of the Distal Articulation Index, the index falls to a very low value and then rises almost to Recent Man values with Cromagnon Man. It is as if palaeolithic man had inherited the *absolute size* of patellar surface of some apelike ancestor placed upon a femur of much increased size. With Cromagnon Man the articular surface is increased in proportion to the size of the femur, and the rotular indices become almost those of Modern Man. If we may trust our values for *Homo aurignacensis* (*Hauseri*), that femur in the distal articulation is not modern, being nearer to Neanderthal than to Recent Man. *Dryopithecus rhenanus* is fairly close to the Recent Gibbon, and those who believe in a gibbonlike ancestry for Man and the Anthropoids may legitimately associate Recent Man with the Gibbon in this character, but if this be done they must clearly place Primogenial Man on a different line of descent, for if Recent Man came through him, Fossil Man and Fossil Gibbon diverge from rather than approach each other.

TABLE LVII. *Rotular Ratio and Diaphysial Rotular Ratio.*

Group		Rotular Ratio		Diaphysial Rotular Ratio	
Lemuroids	*Chiromyrdae* (2)	5·45	Mean 7·93	7·3	Mean 9·37
	Indrisinae (8) ...	6·8		7·6	
	Lorisinae (6) ...	7·2		8·4	
	Galaginae (6) ...	9·05		10·8	
	Tarsiidae (2) ...	9·2		10·6	
	Lemurinae (18) ...	9·9		11·5	
Cebidae	*Pithecia* (2) ...	5·15	Mean 6·08	5·8	Mean 6·94
	Lagothrix (2) ...	5·7		6·8	
	Ateles (4) ...	5·75		6·1	
	Cebus (6) ...	6·0		6·9	
	Brachyurus (2) ...	6·3		7·1	
	Nyctipithecinae (8)	6·3		7·2	
	Mycetes (2) ...	6·25		7·3	
	Hapalinae (16) ...	7·2		8·3	
Simiadae	*Semnopithecus* (10)	6·7	Mean 7·02	7·7	Mean 8·07
	Cynocephalus (8)	6·75		7·8	
	Macacus (14) ...	7·0		8·1	
	Cercocebus (4) ...	7·25		8·3	
	Cercopithecus (8)	7·4		8·45	
	Dryopithecus rhenanus (1) ...	5·9		6·6	
Simiinae	Gibbon (2)	5·7	Mean 7·12	6·45	Mean 8·61
	Chimpanzee (2)	7·2		8·6	
	Gorilla (7)	7·3		8·7	
	Orang (5)	8·3		10·7	
	Pithecanthropus erectus (1) ...	5·3		6·1	
Primogenial Man	Neanderthal Type (6)	3·95		4·7	
	Homo aurignacensis (*Hauseri*) (1)	[4·6]		[5·2]	
	Cromagnon Type (5)	5·4		6·3	
	Grimaldi Type (2)	6·3 ??		7·1 ??	
Recent Man	17th century Londoners ♂ (73)	5·73		6·75 *	
	,, ,, ♀ (62)	5·62		6·61	

* Our Australian femora give Rotular Ratio: ♂ 5·9 (2), ♀ 5·7 (2) and Diaphysial Rotular Ratio: ♂ 7·0 (2), ♀ 6·85 (2), diverging more than our Londoners from the Neanderthal Type.

The *Lorisinae* for this character are nearest to type in the Lemuroids, *Cebus* in the *Cebidae*, *Macacus* in the *Simiadae* and the Chimpanzee in the *Simiinae*.

(*d*) *Rotular Index.* We now turn to our last index of the distal articulation, *i.e.* the Rotular Index, which measures in a rough way the ratio of articular surface height to breadth. The following table gives our data.

Now this table expresses numerically the fact obvious on the inspection of the femora that from *Tarsius* to Neanderthal Man there has been decrease of the patellar height relative to increase of the distal articular breadth. If as we think probable the long tongued patellar articular surface be associated with power of spring (cf. femora of cats, rabbits, hares, etc.[1]), then a big factor in the history of the evolution of the primate femur is the replacement of the power of springing by power of upright gait. Among the Lemuroids *Tarsius* and the Lemurs have the highest index and on this assumption the highest power of spring; the lowest indices are those of the Aye-Aye and *Lorisinae*, but these are far above the average of the *Cebidae*. In that family

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[1] The following table gives the Rotular Index for certain mammals:

Wild Rabbit	78·2
American Agouti	67·7
Domestic Cat	64·9
Lion	48·1
Six-banded Armadillo	40·9

Lagothrix and unexpectedly *Ateles*[1] stand at the bottom while the *Hapalinae* and *Brachyurus*[2] are the most powerful in spring. Among the *Simiadae Macacus* and *Cynocephalus* should be on our hypothesis those most upright in gait, while *Cercopithecus* and *Cercocebus* retain a power of spring of almost a Lemuroid character. *Dryopithecus rhenanus* stands close to the Recent Gibbon which with the Orang are the most agile of the *Simiinae*, while Gorilla and Chimpanzee are the more capable of vertical gait. With Neanderthal Man the index and hypothetically the power of spring reaches its minimum and then begins to ascend through Cromagnon and possibly Grimaldi Types till it reaches again a value in Recent Man little less than that of *Ateles* and the Chimpanzee. If our suggestion be a valid one Recent Man, while retaining his uprightness of gait—the breadth of his distal articulation is as great as that of Neanderthal Man—has recovered something of the ape power of spring—his patellar height has increased beyond that of Neanderthal Man. We have in fact further evidence of that reversion of Recent Man to a more apelike character than that of Primogenial Man, who so to speak overshot the mark.

TABLE LVIII. *Rotular Index.*

Group		Rotular Index	
Lemuroids	*Chiromyrdae* (2) ...	49·7	Mean 69·26
	Lorisinae (6) ...	57·2	
	Indrisinae (8) ...	62·3	
	Galaginae (6) ...	69·4	
	Lemurinae (18) ...	80·2	
	Tarsiidae (2) ...	96·75	
Cebidae	*Lagothrix* (2) ...	32·05	Mean 45·28
	Ateles (4)	38·5	
	Cebus (6)	42·7	
	Pithecia (2) ...	43·95	
	Mycetes (2) ...	47·45	
	Nyctipithecinae (8)	48·9	
	Hapalinae (16) ...	53·0	
	Brachyurus (2) ...	55·7	
Simiadae	*Macacus* (14) ...	45·1	Mean 51·00
	Cynocephalus (8) ...	46·7	
	Semnopithecus (10)	51·0	
	Cercopithecus (8) ...	51·8	
	Cercocebus (4) ...	60·4	
	Dryopithecus rhenanus (1)	47·6	
Simiinae	Gorilla (7)	32·7	Mean 38·15
	Chimpanzee (2)	38·75	
	Orang (5)	43·0	
	Gibbon (2)	48·3	
	Pithecanthropus erectus (1) ...	32·9?	
Primogenial Man	Neanderthal Type (6)	24·0	
	Homo aurignacensis (*Hauseri*) (1)	30·5	
	Cromagnon Type (5)	32·4	
	Grimaldi Type (2)	34·7??	
Recent Man	17th century Londoners ♂ (73) ...	36·75*	
	" " ♀ (62) ...	36·74	

* Our Australians give: ♂ 36·75 (2), ♀ 34·65 (2), and diverge as much as the Londoners from the Neanderthal Type.

If we can rely on the value given for *Pithecanthropus erectus*, it is widely remote from either Recent or Fossil Gibbon. The owner of the Trinil femur had less power of spring than Recent Man's average, although the doubtful value of his index falls within the human range (28 to 43). We may conclude this discussion of the table by noting that the *Galaginae* are nearest to type in the Lemuroids; that the type lies between *Pithecia* and *Mycetes*—or better between *Cebus* and *Nyctipithecinae*, for the former are represented only by two femora apiece—for the *Cebidae*. *Semnopithecus* is exactly type for the *Simiadae* for this character, while the Chimpanzee is again type for the Greater Anthropoids.

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[1] *Ateles* so generally runs parallel to the Gibbon that the result is unexpected. It would be interesting to know the exact difference in mode of progression between *Ateles* and the Gibbon. We cannot account for the position of *Ateles* by supposing a considerable patellar height, but a great breadth of distal articulation; both are in fact mediocre.

[2] The position of *Brachyurus* in all these tables must be taken as open to question, for our specimen was a young one.

C. *General Points as to Distal Articulation.* We may now draw attention to some general points bearing on the seven characters of the distal articulation treated in this section. In all but one case, that of the absolute patellar height[1], both Old and New World Monkeys differ from the Lemuroids in the *same* direction. In view of this it is very difficult to accept such a pedigree as that of Haeckel's which assumes the *Cebidae* to have parted from the main line of descent before but the *Simiadae* later than the Lemuroid stage. Putting aside absolute size in which the *Simiadae* have made much greater progress than the *Cebidae*, out of the five indices the *Simiadae* in two, both those for distal articulation, have gone further from the Lemuroids than the *Cebidae*, but in both these cases the differences are so slight that we might be content to say that in pure distal articulation indices Old and New World Monkeys agree. On the other hand for the three rotular indices the *Simiadae* are sensibly more remote than the *Cebidae* from the Lemuroids. It would thus seem legitimate to argue, *as far as the distal articulation of the femur is concerned*, that both *Cebidae* and *Simiadae* came off from a Lemuroid ancestry and fixed the distal articulation ratio and index before separation; that after separation the *Simiadae* retained or developed higher rotular indices than the *Cebidae*, *i.e.* may have had a tendency to revert towards the Lemuroids; that this manifests itself to the full in the Greater Anthropoids, which are practically lemuroid in the rotular ratios, but in the rotular index—that which makes in our opinion for upright gait—the Greater Anthropoids have carried out the progression started in the *Cebidae*, the progression which leads to Man, while the Gibbon, in both fossil and recent forms, has scarcely bettered the position of the *Simiadae*, and remained essentially a springing animal.

With regard to type forms for the articulation of the distal epiphysis our results seem to indicate that the *Lorisinae*[2] form the type for the Lemuroids with three firsts and one second out of seven characters; that *Cebus* is the type for the *Cebidae* with four firsts and one second; that *Macacus* with three firsts and one second is type for the *Simiadae*; while the Chimpanzee with four firsts and one second is type for the Greater Anthropoids.

We trust that this slight investigation of the distal articular surface will indicate how much of interest would arise from a fuller discussion of this surface not only for the primates but for the mammals as well.

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[1] Even in this case all we can say is that the *Cebidae* do not differ sensibly in patellar height from the Lemuroids.

[2] The Lemur is only closest to type in one and second in two characters; a position equalled by *Tarsius*.

(x) *Concluding Remarks on the Distal Epiphysis.*

The accompanying table gives our reconstruction of the hypothetical Protsimio-human. We note again how close in many respects are the indices to those of Recent Man, the values of which were not considered in our determination. This seems to us to emphasise the point that many of the human femoral characters are more primitive than has been anticipated and we hold that the Greater Anthropoids have diverged from a type which was not without many human characters. At the same time that type indicially is usually intermediate between Recent Man and Recent Chimpanzee, while Recent Gibbon lies as a rule outside that range. In those characters in which Man and Chimpanzee are widely divergent from the Gibbon our Protsimio-human will be found to follow the former and not the latter, in other words its femur is troglodytic not hylobatic. Thus the distal epiphysis confirms the surmises we have made from the indices of the shaft and the proximal epiphysis.

TABLE LIX. *Characters of the Distal Epiphysis of the Hypothetical Protsimio-human.*

Character	Recent Gibbon	Protsimio-human	Recent Chimpanzee	Recent Man
Bicondylar Width	25·25	62·0	69·3	74·88
Max. Length Ext. Condyle ...	18·0	47·7	43·4	59·28
Max. Length Int. Condyle ...	19·15	47·7	51·5	58·81
Oblique Length Ext. Condyle ...	17·45	46·3	41·45	58·46
Oblique Length Int. Condyle ...	17·6	43·9	45·45	54·20
Ext. Cond. Hor. Band-radius ...	7·45	18·0	20·1	17·85
Ext. Cond. Vert. Band-radius ...	7·25	17·8	19·55	19·65
Height, Patellar Surface ...	10·95	19·5	22·6	24·34
Breadth, Distal Articulation ...	22·6	52·1	58·3	66·23
Condylar Index	74·4	77·0	62·65	79·0
Condylar Lengths Index ...	94·1	100·0	84·2	100·57
Bicondylar Ratio	13·05	19·1	22·0	17·54
Band-radial Index	97·8	99·0	97·25	111·36
Condylar Troch. Index	9·4	15·0	13·95	14·57
Distal Articulation Ratio ...	11·75	16·0	18·55	15·52
Distal Articulation Index ...	89·7	84·0	84·15	89·05
Rotular Ratio	5·7	6·0	7·2	5·67
Rotular Index	48·3	37·4	38·75	36·75
Diaphysial Rotular Ratio ...	6·45	7·14	8·6	6·68

We fear the reader will consider our discussion of the distal epiphysis singularly incomplete and we frankly admit the truth of the criticism; but this incompleteness arises, however, largely from the fact already referred to, namely that comparative human material is almost entirely wanting, and in view of this our aim has been to suggest the interesting problems which are associated with the femoral part of the knee-joint rather than to assert dogmatic conclusions. In the intervals of more engrossing war work, it has been easier to work on the femora of monkeys and apes, than to deal *de novo* with long series of human femora, which are only to be found in continental, especially French Museums. But this very extension of our work to the lower primates has opened up broader and more general problems than could arise from interracial data in the case of Man, and we hope that this fact may to some extent compensate the anthropologist for the absence of comparative human material in this section. That absence indeed may suggest questions to be answered if he has the osteometric material at his disposal, while to those anthropologists, who are living in touch with the primitive races of to-day, we would appeal begging them to remember that this monograph has striven to demonstrate that crania are not the only material which it is valuable to collect and forward to the museums and laboratories of this country.

(xi) *An Examination of the Dwarf Femur.*

We have noted in the course of our discussion on the femur of Recent Man that we meet with simiine and even lemuroid reversions in certain of the anomalies of the human femur; we have further noted that these anomalies not infrequently appear to be associated with pathological femoral conditions (see our p. 107 and elsewhere). On our hypothesis the prot-simio-human femur was a short robust femur of a troglodyte character, 40 °/₀ longer than that of the Recent Chimpanzee, it is true, but 20 °/₀ shorter than that of Recent Man; it would have accordingly much the size of the femur of dwarf Recent Man. It appeared just worth the while to inquire whether the femur of the human dwarf has any characters, which can be looked upon as at all reversions to our prot-simio-human femur. We devote this section to certain comparative measurements intended to throw light on this point.

It is well known that human dwarfs may be divided into three broad classes: namely (i) the Racial Dwarfs or true Pygmies, and the Pathological Dwarfs divided into the two main groups, (ii) Ateleiotic Dwarfs and (iii) Achondroplasic Dwarfs[1]. Of the racial dwarfs we have been able to measure the femora of two Bushmen, and an Andaman from the Museum of the Royal College of Surgeons. We have not studied the Akka femur, owing to the necessity during the past few years of working on material which could be at once picked up and dealt with in the brief intervals of other work. For the pathological dwarfs we have both femora of a dwarf from Ancient Egypt. This dwarf appears to us to be ateleiotic from the femora although the skull is of large size. A notable feature is the great difference with regard to quite a number of characters of the right and left femora of this dwarf[2]. Lastly we have an excellent example of true achondroplasia in the femur of a dwarf from Khartoum. The skeletons of these last two dwarfs are also in the Museum of the Royal College of Surgeons. In the following table we place the measurements of these dwarfs against those of our Prot-simio-human and of two very primitive types of femora, namely: (*a*) the mean of two Australian aboriginal males

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[1] See the *Treasury of Human Inheritance*, Vol. I, pp. 355 *et seq.* Cambridge University Press.

[2] From the pathological side this skeleton has been very fully discussed by Dr Douglas E. Derry: "A case of Hydrocephalus in an Egyptian of the Roman Period," *Journal of Anatomy and Physiology*, Vol. XLVII, pp. 436—458, London, 1913. He notes hemiplegia and partial paralysis of left side, but does not emphasise the dwarfism.

TABLE LX. *Comparison of Prot-simio-human Femur with those of Racial and Pathological Dwarfs and with Primitive Femora.*

	Characters	Absolute Values									
		Australian Aboriginal (2) ♂	"Primitive" Human Femur (1) ♂ L.	Prot-simio-human	Chimpanzee (2)	Achondroplasic Dwarf L.	Ateleiotic Dwarf R.	Ateleiotic Dwarf L.	Racial Dwarfs		
									Bushman ♀ A (L.)	Bushman ♀ B (R.)	Andaman R.
MAJOR LENGTHS	Maximum Length	451·45	456·5	325	314·55	263·5	383·8	380·0	437·0	384·0	367·5
	Trochanteric Length	425·0	445·0	318	311·0	263·5	355·1	358·8	414·5	371·2	339·5
	Maximum Troch. Length	438·7	452·0	322·5	313·35	267·0	365·9	362·0	426·7	372·8	347·5
	Oblique Length	444·3	455·5	322·5	311·85	262·0	378·2	379·5	428·0	382·0	363·5
	Troch. Oblique Length	417·3	445·0	318	311·85	263·0	352·1	360·0	404·7	370·0	338·5
	Capito-trochlear Length	431·15	441·5	301	303·65	241·2	362·8	361·2	417·5	368·7	349·1
	Diaphysial Length	381·5	401·0	273	261·8	197·0?*	317·5	323·5	376·0	332·5	304·2
	Length of Shaft	384·6	396·0	271·5	257·35	200·6	328·9	324·0	375·9	332·7	307·9
BUST	Vert. Diam. of Head	49·05	46·5	36·0	36·15	44·2	43·5	44·5?	41·6	35·4	35·6
	Horiz. Diam. of Head	47·45	45·7	35·8	36·2	44·9	42·5	40·8	40·9	35·4	35·6
	Min. Horiz. Diam. of Neck ...	23·9	23·9	19·7	17·55	20·3	23·4	21·6	22·2	20·0	19·3
	Min. Vert. Diam. of Neck... ...	36·83	34·2	25·2	22·7	20·4	31·5	31·5	30·7	25·4	23·2
	Capito-collar Length	81·1	80·0	51·5	62·4	58·9	48·8	50·0	58·3	55·3	56·7
	Length of Neck	56·6	56·75	33·5	44·3	36·8	27·05	27·75	37·5	37·6	38·9
SHAFT	Proximal Breadth	104·8	102·3	70·0	68·5	75·5	85·4	78·7	83·7	72·6	76·4
	Platymeric A. P. Diam.	25·8	27·5	22·7	21·95	21·3	25·0	19·5	23·6	18·4	19·4
	Platymeric Trans. Diam.	32·9	36·4	25·8	26·2	28·2	26·4	27·3	29·5	24·2	23·4
	Pilastric A. P. Diam.	29·85	35·2	22·8	21·4	24·0	27·3	26·4	32·6	21·0	24·6
	Pilastric Trans. Diam.	27·5	30·1	23·25	25·85	25·2	22·1	17·2!	25·0	22·2	19·7
	Popliteal Length	121·75	97·5	102·3?	123·15?	79·2?	71·4	105·6	89·1	100·4	111·7
	Popliteal Width	41·35	43·6	31·0	34·35	34·1	38·1	32·1	37·1	32·3	31·9
	Poplit. Direct A. P. Diam. ...	32·5	31·6	21·7	23·45	23·8	27·9	21·2	28·8	21·5	21·0
	Poplit. Oblique A. P. Diam. ...	32·75	34·1	22·4	25·15	24·1	28·3	23·5	31·4	23·0	25·0
	Diaphysial Chord	261·85	282·7	182·1	179·8	134·2	211·9	209·2	242·2	231·6	207·3
	Diaphysial Subtense	8·35	9·3	5·6	5·25	± 1·2†	4·5	5·2	6·0	8·2	7·7
	Prox. Segm. Diaph. Chord ...	100·15	102·7	89·2	77·2	?	108·1	95·5	105·1	91·2	83·2
CONDYLES	Bicondylar Width	79·85	84·8	62·0	69·3	76·4	74·6	74·0	70·9	64·5	63·8
	Max. Length Ext. Condyle ...	65·95	64·6	47·7	43·4	60·5	59·7	58·9	54·2?	52·9	53·2
	Max. Length Int. Condyle ...	66·3	67·8	47·7	51·5	62·9	52·3	51·8	55·3	51·6	52·6
	Oblique Length Ext. Condyle ...	65·35	63·4	46·3	41·45	56·7	57·6	55·7	52·8	52·4	52·6
	Oblique Length Int. Condyle ...	60·85	59·5	43·9	45·45	53·9	48·9	48·9	52·0	48·5	50·1
	Ext. Condylar Hor. Band-radius ...	19·4	21·5	18·0	20·1	20·5	17·4	18·2?	19·1?	18·0	17·7
	Ext. Condylar Vert. Band-radius	21·6	21·8	17·8	19·55	17·5	16·7	16·9?	16·9?	15·9	18·0
	Height, Patellar Surface	26·65	26·2	19·5	22·6	27·7	23·7	22·2	24·3	21·6	18·5
	Breadth, Distal Articulation ...	72·9	77·1	52·1	58·3	68·8	67·3	67·8	64·2?	61·2	62·3
ANGLES	Mid-trochlear Angle	9°·15	10°·0	8°·5	9°·0	11°·3	5°·5	6°·2	5°·7	6°·8	6°·8
	Angle at Centre of Head	50°·7	55°·0	51°·0	37°·75	42°·0	43°·1	40°·9	42°·1	46°·1	39°·2
	Collar Angle	120°·15	115°·0	120°·5	133°·25	126°·7	131°·4	132°·9	132°·2	127°·1	134°·0
	Torsion of Shaft	6°·1	20°·0	15°·0	10°·5	21°·5	8°·5	101°·5!!	38°·5	39°·5	39°·0
	Torsional Angle	– 5°·25	9°·6	6°·0	3°·75	1°·0	– 22°·0	+ 54°·5!	– 6°·5	12°·7	15°·7
	Retorsional Angle	11°·35	10°·4	9°·0	6°·75	20°·5	30°·5	47°·0	45°·0	26°·8	23°·3
	Obliquity of Shaft	15°·15	7°·0	3°·0	– 0°·1	6°·5	8°·5	4°·0?	14°·5	9°·0	8°·5
	Pseudo-obliquity	10°·15	3°·8	7°·1	7°·5	6°·1	9°·8	2°·9	11°·6	5°·8	8°·5

* There is a broad and fairly deep groove between patellar surface and shaft.

† The curvature of anterior face of shaft exhibits a point of inflexion, *i.e.* is double-bellied.

	Characters	Indicial Values									
		Australian Aboriginal (2) ♂	"Primitive" Human Femur (1) ♂ L.	Prot-simio-human	Chimpanzee (2)	Achondroplasic Dwarf L.	Ateleiotic Dwarf R.	Ateleiotic Dwarf L.	Racial Dwarfs		
									Bushman ♀ ? A (L.)	Bushman ♀ B (R.)	Andaman R.
General Indices	Oblique Direct Lengths Index	98·84	99·78	99·23	99·1	99·43	98·54	99·87	97·94	99·48	98·91
	Oblique Direct Troch. Lengths Index	97·89	100·00	100·00	100·3	99·81	99·15	100·33	97·64	99·68	99·71
	Proximal Breadth Ratio	24·66	22·99	22·0	22·15	28·65	24·05	21·93	20·19	19·56	22·50
	Distal Breadth Ratio	18·79	19·06	19·5	22·25	28·99	21·01	20·62	17·10	17·38	18·79
	Pithecoid Index	93·9	97·7	98·6	100·0	100·4	93·1	94·9	94·6	96·9	93·1
	Robusticity of Femur	12·91	14·34	14·3	15·15	18·78	13·06	11·49	13·46	11·31	12·19
Bust Indices	Robusticity of Head	21·7	20·2	22·3	23·2	34·0	22·7	22·5 ?	19·3	18·5	19·6
	Ellipticity of Head	96·8	98·3	99·4	100·15	101·6	97·7	91·7	98·3	100·0	100·0
	Ellipticity of Neck	65·8	69·9	78·0	77·3	99·5	74·3	68·6	72·3	78·7	83·2
	Secondary Index of Neck	50·4	52·3	55·0	48·5	45·2	55·1	52·9	54·3	56·5	54·2
	Lemotic Index	12·75	12·5	10·4	14·2	14·0	7·2	7·3	8·8	9·8	10·1
	Head Bust Ratio	60·6	58·1	69·9	57·95	75·0	89·1	89·0 ?	71·3	64·0	62·8
	Primary Bust Ratio	17·95	17·5	15·8	19·85	22·4	12·7	13·2	13·3	14·4	15·4
	Secondary Bust Ratio	18·25	17·6	16·0	20·05	22·5	12·9	13·2	13·6	14·5	15·6
	Bust Shaft Index	21·1	20·2	19·0	24·25	29·4	14·8	15·4	15·5	16·6	18·4
	Capital Ratio	10·85	10·2	11·1	11·5	16·8	11·3	11·7 ?	9·5	9·2	9·7
	Capito-bicondylar Ratio	61·4	54·3	58·1	52·2	57·8	58·3	60·1 ?	58·7	54·9	55·8
	Epiphysial Ratio	101·65	94·3	83·1	90·0	77·1	65·4	67·6	82·2	85·7	88·9
Shaft Indices	Platymeric Index	78·45	75·6	88·0	83·8	75·5	94·7	71·4	80·0	76·0	82·9
	Pilastric Index	108·65	116·9	98·0	82·8	95·2	123·5	153·5 !	130·4	94·6	124·9
	Popliteal Index	78·6	72·5	70·0	68·25	69·8	73·2	66·0	77·6	66·6	65·8
	Index of Popliteal Skewness	99·25	92·7	96·9	93·35	98·8	98·6	90·2	91·7	93·5	84·0
	Popliteal Pyramidal Index	34·05	44·7	30·3?	27·95?	43·1 ?	53·4	30·4	41·6	32·2	28·6
	Soffit Index	51·75	51·4	50·0	49·55	44·6	51·1	43·4	52·3	50·1	50·0
	Index of Gracility (Upper)	83·6	82·7	90·0	98·7	89·4	83·7	63·0	84·7	91·7	84·2
	Index of Gracility (Lower)	66·55	69·0	75·0	75·25	73·9	58·0	53·6	67·4	68·7	61·7
	Index of Trans. Slenderness	7·15	7·6	8·6	10·05	12·6	6·7	5·3	6·7	6·7	6·4
	Index of Sagit. Slenderness	7·8	9·1	8·4	8·3	12·0	8·3	8·1	8·7	6·3	8·0
	Index of Prox. Taper	86·45	78·1	99·6	102·35	88·8	91·6	73·9	72·4	87·6	78·9
	Index of Distal Taper	108·9	89·8	95·2	109·55	99·2	102·2	80·3	88·3	102·4	85·4
	Popliteal Shaft Index	31·65	24·6	37·7	47·85	39·5 ?	21·7	32·6	23·7	30·2	36·3
	Primary Index of Bowing	3·15	3·3	3·2	2·95	[±0·9]*	2·1	2·5	2·5	3·5	3·7
	Secondary Index of Bowing	38·3	36·3	49·0	42·95	?	51·0	45·7	43·4	39·4	40·1
Condylar Indices	Condylar Index	82·6	76·2	77·0	62·65	79·2	80·0	79·6	76·4 ?	82·0	83·4
	Condylar Lengths Index	99·5	95·3	100·0	84·2	96·2	114·1	113·7	98·0 ?	102·5	101·1
	Bicondylar Ratio	17·65	18·6	19·1	22·0	29·0	19·4	19·5	16·2	16·8	17·4
	Band-radial Index	111·4	101·4	99·0	97·25	85·4	96·0	92·9?	88·5 ?	88·3	101·7
	Condylar Troch. Index	15·5	14·5	15·0	13·95	23·0	16·8	16·4	13·1 ?	14·3	15·7
	Distal Articulation Ratio	16·15	16·9	16·0	18·55	26·1	17·5	17·8	14·7 ?	15·9	16·9
	Distal Articulation Index	91·3	90·9	84·0	84·15	90·1	90·2	91·6	90·5	94·9	97·6
	Rotular Ratio	5·9	5·7	6·0	7·2	10·5	6·2	5·8	5·6	5·6	5·0
	Rotular Index	36·75	34·0	37·4	38·75	40·3	35·2	32·7	37·9 ?	35·3	29·7
	Diaphysial Rotular Ratio	7·0	6·5	7·15	8·6	14·1 ?	7·5	6·9	6·5	6·5	6·1

* See second footnote on preceding page.

in our possession and (*b*) a singularly primitive human femur, obviously of considerable antiquity, of which we have no history, also in our Laboratory.

(*a*) *Angles.* Now there is little to be learnt from absolute size because our fundamental length for the Prot-simio-human is very arbitrary and might easily be 25 mm. in excess or defect. On the other hand the absolute values of the femoral angles are of importance and we see that the fundamental triangle for the Prot-simio-human differs not only from that of Recent Man (angles 7°·8, 41°·5, 130°·7), but from those of both pathological and racial dwarfs, which are singularly close to that of Recent Man as typified by our Londoners. It is obviously closer to the primitive type of human femur as exhibited in the first two columns.

Again the torsion of the shaft is higher in the racial dwarfs (39°·0) than in Recent Man (25°·0), to which latter value the achondroplasic femur (21°·5) approaches. The Prot-simio-human femur belongs again to the relatively low torsion of the shaft group represented by the primitive femora of the first two columns. Little can be said of the ateleiotic dwarf unless we hide the truth under a mean! His right femur exhibits low torsion of the shaft (8°·5), similar in intensity to the Australians (6°·1), but his left femur has a higher grade of shaft torsion (101°·5) than we have ever before encountered. This is only saying that this dwarf's left femur is certainly deformed, as may also be observed in the pilastric diameters and index. In the case of retorsion, both kinds of dwarfs exhibit a high degree of it; the primitive femora and the Prot-simio-human a low degree of it. Lastly for the torsion of the femur in the ordinary sense the Prot-simio-human agrees with the primitive femora in having a low degree of it. The Andaman and one Bushman have a moderate amount of torsion similar to that of Recent Man (about 14°·0). The other Bushman has a small negative torsion, while the achondroplasic dwarf has a negligible torsion and the ateleiotic dwarf shows in the two members opposite exaggerations of torsion. Thus as in so many racial problems little is to be learnt from the femoral torsion proper. In the case of the obliquity the racial dwarfs give a mean of 10°·7 not very different from that of our Londoners (10°·4). The pathological dwarfs show a lower degree of obliquity (about 6°·3), while the Prot-simio-human has but a slight degree of obliquity. We should have anticipated only a small amount of obliquity in the "primitive race" femora—as in primogenial man; but this is certainly not the case with the Australians. Thus as far as it goes in this character the pathological dwarfs come somewhat nearer to the Prot-simio-human. For the whole series of angles, however, it is not possible to say that either pathological or racial dwarfs are more Prot-simio-human in character than non-dwarf primitive races.

(*b*) *General Indices.* With regard to the indices we find among the general indices that little can be learnt from the Oblique Direct Lengths Indices, whether for the capital or trochanteric lengths. Thus, in the case of the former, the primitive race femora have a value 99·3, the same as that of our Londoners and both in excess of the racial dwarfs, 98·8. The achondroplasic and ateleiotic femora might both be variations from that of Recent Man, and the same may equally be said of the Protsimio-human femur. More significant results flow from the robusticity of the femur. Here we have:

Achondroplasic Dwarf ...	18·8	Advanced Races ...	12·7
Prot-simio-human ...	14·3	Racial Dwarfs	12·3
Primitive Races... ...	13·6	Ateleiotic Dwarf ...	12·3

It is clear that the Prot-simio-human is separated by Recent Man from both ateleiotic and racial dwarfs, and that it is impossible to consider the exaggerated robusticity of achondroplasia as a reversion to a simian ancestry.

The Pithecoid Index gives us the following result:

Achondroplasic Dwarf ...	100·4	Advanced Races ...	95·2
Prot-simio-human ...	98·6	Racial Dwarfs	94·9
Primitive Races ...	95·8	Ateleiotic Dwarf ...	94·0

Thus the Racial and Ateleiotic Dwarfs are further removed from the Prot-simio-human than either group of Recent Man. The Achondroplasic Dwarf is, however, more simian than the Prot-simio-human for this character. We may not be able accurately to describe this fact as a reversion of the achondroplasic femur to the Prot-simio-human type, but it is certainly one among several features in which the achondroplasic bone is more simian not only than Recent Man, but than the Prot-simio-human itself.

For the Proximal and Distal Breadth Ratios we have:

	Proximal Breadth Ratio		Distal Breadth Ratio
Achondroplasic Dwarf ...	28·7	Achondroplasic Dwarf ...	29·0
Primitive Races	23·8	Ateleiotic Dwarf	20·8
Ateleiotic Dwarf	23·0	Prot-simio-human	19·5
Advanced Races	22·1	Primitive Races	18·9
Prot-simio-human	22·0	Advanced Races	18·5
Racial Dwarfs	21·1	Racial Dwarfs	17·8

In both cases the advanced races are nearer to the Prot-simio-human than any type of dwarf. It is not possible therefore to speak of the relative size of the epiphyses as a case in which any type of dwarf shows a reversion from normal man to a Prot-simio-human ancestor.

Accordingly the General Indices of the femur give no systematic support to the hypothesis that the dwarf is a reversion to or a survival of a distant ancestral form.

We may now consider the indices of the three chief portions of the femur.

(*c*) *Indices of the Shaft.* First, those of the shaft. We have summarised the results in Table LXI.

Now in analysing this summary we may dismiss at once any index where the Prot-simio-human lies between or on the borders of the range of values given for Recent Man, for it is clearly not possible in such a case to speak of reversion. Also, if an index for the dwarfs lies in this range it may again be dismissed from our consideration.

On the first ground we need not concern ourselves with the Popliteal Index, Index of Popliteal Skewness, Soffit Index, Index of Sagittal Slenderness, or the Primary Index of Bowing.

Now let us consider the Racial Dwarfs. The values of the Platymeric, Popliteal Pyramidal, Popliteal Shaft Indices and that of Proximal Gracility lie between those of Recent Man. The values of the Pilastric Index and the Indices of Distal Gracility, Transverse Slenderness and Proximal Taper lie outside the range for Recent Man, *but on the* other side of that range to the Prot-simio-human. This leaves only two out of the 15 indices of the shaft considered in which we could even suggest reversion. Of these the value of the Secondary Index of Bowing is four times closer to that of advanced man than to that of the Prot-simio-human. In the remaining fifteenth index the racial dwarf has so far overshot the mark that the Prot-simio-human is four times closer to the femur of the advanced races than to that of the Racial Dwarf. It will be seen that the shaft gives no evidence whatever that the Racial Dwarf is in any way a reversion or a relic of a Prot-simio-human ancestor. As far as the shaft is concerned we find no suggestion that man has ascended from a Prot-simio-human stage through a racial dwarf phase.

TABLE LXI. *Indices of the Shaft.*

Indices	Recent Man		Prot-simio-human	Dwarfs		
	Primitive	Advanced		Racial	Ateleiotic	Achondroplasic
Platymeric Index	77·0	84·0	88·0	79·6	83·0	75·5
Pilastric Index	112·8	103·0	98·0	116·6	138·5	95·2
Popliteal Index	75·6	69·4	70·0	70·0	69·6	69·8
Index of Popliteal Skewness ...	96·0	90·8	96·9	89·7	94·4	98·8
Popliteal Pyramidal Index ...	39·4	32·9	30·3	34·1	41·9	43·1 ?
Soffit Index	51·6	50·4	50·0	50·8	47·3	44·6
Index Proximal Gracility ...	83·2	88·7	90·0	86·9	73·4	89·4
Index Distal Gracility ...	67·8	70·9	75·0	65·9	55·8	73·9
Index Trans. Slenderness ...	7·4	7·4	8·6	6·6	6·0	12·6
Index Sagittal Slenderness ...	8·4	7·5	8·4	7·7	8·2	12·0
Index of Proximal Taper ...	82·3	92·0	99·6	79·6	82·7	88·8
Index of Distal Taper ...	99·3	96·0	95·2	92·0	91·3	99·2
Popliteal Shaft Index ...	28·1	32·2	37·7	28·8	26·2	39·5 ?
Primary Index of Bowing ...	3·2	2·5	3·2	3·2	2·3	± 0·9
Secondary Index of Bowing ...	37·3	39·0	49·0	41·0	48·4	?

We next turn to the Ateleiotic Dwarf. The following indices lie in the Recent Man range: Platymeric Index and Index of Proximal Taper. The following indices lie outside the Recent Man range but on the opposite side to the Prot-simio-human, namely, the Pilastric, the Popliteal Pyramidal, and the Popliteal Shaft Index, together with the Indices of Proximal and Distal Gracility and of Transverse Slenderness. We are thus again reduced to the Index of Distal Taper and the Secondary Index of Bowing. Now, the Index of Distal Taper is for our ateleiotic dwarf: R. 102·2 and L. 80·3. It is impossible to consider either of these values as a reversion to a Prot-simio-human value of 95·2! We are thrown back, therefore, on a single index, that of secondary bowing, as the sole suggestion of reversion. We may, therefore, certainly dismiss this type of dwarf from our consideration as a possible reversion.

We now turn to the other pathological dwarf, the achondroplasic. Here there are only 14 indices to be considered[1]; those of Proximal and Distal Taper lie in the Recent Man range; the Platymeric and Popliteal Pyramidal Indices lie outside that range, but on the opposite side of it to the Prot-simio-human value. There remain five indices for consideration. In the case of the Index of Proximal Gracility, the prot-simio-human value is 1·3 points (90·0) from the advanced race value (88·7) and the achondroplasic value as nearly as possible is midway between the two (89·4). No stress can therefore be laid on this as a possible case of reversion. The Index of Transverse Slenderness is so exaggerated in the case of the achondroplasic femur, that the value of this index for the Prot-simio-human is three times at least nearer to that of the advanced races. It seems again impossible to suggest that this is reversion! On the other hand, if we take the Pilastric and the Popliteal Shaft Indices, together with the Index of Distal Gracility, there is a distinct approximation in these features to a more simian form. The pilastric transverse, as in most apes, is greater than the pilastric antero-posterior diameter, the distal portions of mesial and lateral faces are more nearly vertical, and the popliteal apex is relatively higher up the shaft. We must not argue that these are only pathological results, for the very essence of the pathological condition might be that it released "determinants" long since inactive in the case of Recent Man. Before expressing a final opinion it seems desirable to consider whether similar approximations in character are to be found when we deal with the epiphyses.

(*d*) *Indices of the Proximal Epiphysis.* We turn now to the proximal epiphysis, and summarise our results in the following table.

TABLE LXII. *Indices of the Bust.*

Indices	Recent Man		Prot-simio-human	Dwarfs		
	Primitive	Advanced		Racial	Ateleiotic	Achondro-plasic
Robusticity of Head	21·5	20·6	22·3	19·1	22·6	34·0
Ellipticity of Head	97·5	99·0	99·4	99·4	94·7	101·6
Ellipticity of Neck	67·8	75·3	78·0	78·1	71·4	99·5
Secondary Index of Neck ...	51·3	55·4	55·0	55·0	54·0	45·2
Lemotic Index	12·6	11·8	10·4	9·9	7·2	14·0
Head Bust Ratio	59·3	61·0	69·9	66·0	89·0	75 0
Primary Bust Ratio	17·7	17·0	15·8	14·4	12·95	22·4
Secondary Bust Ratio ...	17·9	17·1	16·0	14·6	13·05	22·5
Bust Shaft Index	20·7	20·05	19·0	16·8	15·1	29·4
Capital Ratio	10·5	10·3	11·1	9·5	11·5	16·8
Capito-bicondylar Ratio ...	57·9	58·6	58·1	56·5	59·2	57·8
Epiphysial Ratio	98·0	96·5	83·1	85·6	66·5	77·1

Here we can only dismiss two indices, the Secondary Index of the Neck and the Capito-bicondylar Ratio, because the Prot-simio-human's values lie in the Recent Man range.

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[1] Five of these are already dealt with, for the Prot-simio-human values lie in the Recent Man range.

Turning to the Racial Dwarfs, we note that the value of no single index lies in the Recent Man range. In the following indices the value lies on the opposite side of the Recent Man range to the Prot-simio-human value: Robusticity of Head and Capital Ratio. This position follows from the fact that the *Racial* Dwarf has a head small as compared with the femoral length, while the Prot-simio-human has a relatively large head. Neither the ateleiotic nor the achondroplasic dwarfs resemble the racial dwarfs in this aspect. In the remaining eight indices the racial dwarf recedes from Recent Man in the same direction as the Prot-simio-human. In two of these indices, the Ellipticity of Head and the Ellipticity of Neck, there is close agreement, and in the Secondary Index of the Neck there is also identity. In proportions of head to bust and of bust to shaft racial dwarf and Prot-simio-human show tendencies in marked correspondence, namely the head is large as compared to bust and the bust is small as compared to shaft. These features are also maintained in the ateleiotic dwarf, where, however, the ellipticities are very divergent from the Prot-simio-human values. In Robusticity of Head, *i.e.* in the size of head relative to the femoral length, however, the ateleiotic dwarf approaches closer to the Prot-simio-human type. The correspondence of the racial dwarf with the Prot-simio-human in the proportion of bust to size of femur is the more noteworthy, as it is precisely here that the Prot-simio-human is less like the Chimpanzee (see Table LX, p. 434), *i.e.* less troglodytic and more hylobatic. We must accordingly admit in the bulk of the indices of the bust a considerable approximation of the racial dwarf to the Prot-simio-human, but this relationship appears to be associated with a hylobatic rather than a troglodyte tendency in both.

We now turn to the Ateleiotic Dwarf. Here only Ellipticity of Neck lies in the Recent Man ranges, so that we have nine remaining indices to consider. Of these Ellipticity of Head is on the opposite side of the Recent Man range to the Prot-simio-human value and may be dismissed. In two others, the Robusticity of Head and Capital Ratio, the Ateleiotic Dwarf is closer to the Prot-simio-human than the Racial Dwarf for the dimensions of his femoral head, owing to his infantilism, are more troglodyte as they are in the human child[1]. In the remaining six indices the deviations of the ateleiotic femur from that of Recent Man are markedly exaggerated, so that in all six the Prot-simio-human is nearer to Recent Man of the advanced races than to the Ateleiotic Dwarf. Had such a comparison been possible we should probably have found the *non-adult* Prot-simio-human closer to the Ateleiotic Dwarf. As it is, it is the proximal epiphysis of the Racial Dwarf—excepting the relative size of the head—which corresponds most closely to that of the Prot-simio-human.

Turning lastly to the Achondroplasic Dwarf, we have ten indices to discuss. Four of these, the Lemotic Index, the Primary and Secondary Bust Ratios and the Bust Shaft Index, can be at once dismissed, for they lie on the opposite side of the Recent Man range to the Prot-simio-human indices. In just the very characters wherein the Prot-simio-human femur approaches the hylobatic the achondroplasic femur tends to the troglodytic! In the remaining six indices the exaggeration of the troglodytic tendency is so great that all resemblance to the Prot-simio-human disappears. The Robusticity of the Head and the Capital Ratio exceed those of the male Gorilla, the Ellipticity of the Head is somewhat in excess of either Gorilla or Chimpanzee, the rotundity of the neck exceeds that of some femora of the Neanderthal Type, to which also the Head Bust Ratio approximates. The Epiphysial Ratio is also Neanderthalloid. Shortly, if the Achondroplasic Dwarf is to be looked upon as a reversion, it is a reversion in its proximal epiphysis rather to the Chimpanzee or to Neanderthal Man than to our Prot-simio-human.

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[1] For example, if we deal with robusticity of the head, Rodriguez gives for 94 adult Japanese: mean ♂ 22·16, ♀ 21·07, but for 16 young Japanese regardless of sex: mean 22·30. See Bibl. 10, p. 29.

We conclude, therefore, that as far as the indices of the bust are concerned, we can only find a valid association between the Racial Dwarf and our Prot-simio-human.

(*e*) *Indices of the Distal Epiphysis.* Lastly we turn to the Indices of the Distal Epiphysis, which are summarised in the table below. Of the ten indices three, the Condylar Lengths Index, Condylar Trochanteric Index and the Distal Articulation Ratio, may be dismissed at once from consideration, as their values for the Prot-simio-human lie in the Recent Man range.

TABLE LXIII. *Indices of the Distal Epiphysis.*

Indices	Recent Man		Prot-simio-human	Dwarfs		
	Primitive	Advanced		Racial	Ateleiotic	Achondroplasic
Condylar Index	79·4	79·0	77·0	80·9	79·8	79·2
Condylar Lengths Index ...	97·4	100·6	100·0	100·5	113·9	96·2
Bicondylar Ratio	17·1	17·55	19·1	16·8	19·4	29·0
Band-radial Index	106·4	111·4	99·0	92·8	94·5	85·4
Condylar Trochanteric Index	15·0	14·6	15·0	14·4	16·6	23·0
Distal Articulation Ratio ...	16·5	15·5	16·0	15·8	17·6	26·1
Distal Articulation Index ...	91·1	89·05	84·0	94·3	90·9	90·1
Rotular Ratio	5·8	5·7	6·0	5·4	6·0	10·5
Rotular Index	35·4	36·75	37·4	34·3	34·0	40·3
Diaphysial Rotular Ratio ...	6·7	6·7	7·15	6·4	7·2	14·1

We now take the Racial Dwarfs. For Condylar Index, Bicondylar Ratio, Distal Articulation Ratio, Rotular Ratio, Rotular Index and Diaphysial Rotular Ratio, the indicial values lie on the opposite side of the Recent Man range to the Prot-simio-human. There can thus be absolutely no question of the racial dwarfs exhibiting a special association in distal epiphysis with the Prot-simio-human. They cannot for this portion of the femur be looked upon as preserving an earlier stage of Recent Man.

We next turn to the Ateleiotic Dwarf. Here in Condylar Index and Rotular Index the values for this dwarf are on the opposite side of the Recent Man range to those of the Prot-simio-human. In the Distal Articulation Index this dwarf lies in the Recent Man range. Thus for comparative purposes we have only to consider four indices. Of these three approach closely the Prot-simio-human values, namely the Bicondylar Ratio, the Rotular Ratio and the Diaphysial Rotular Ratio. The high values of these indices are what we should anticipate if the distal epiphysis in the

Ateleiotic Dwarf, as compared with femoral or shaft lengths, is exaggerated[1]. This corresponds to what we have found for the ateleiotic dwarf in the case of the proximal epiphysis, and marks an important distinction between the ateleiotic and racial dwarfs.

Lastly we consider the Achondroplasic Dwarf. In the proportions of the distal epiphysis as represented by Condylar Index and Distal Articulation Index he lies in the Recent Man range. But in the Bicondylar Ratio, Rotular Ratio and Diaphysial Rotular Ratio he enormously exaggerates the troglodyte tendency of the Prot-simio-human, *i.e.* the dimensions of the distal epiphysis are very great as compared to both femoral and shaft lengths. In Bicondylar Ratio, Rotular Ratio and Diaphysial Rotular Ratio he leaves the Gorilla far behind. But the Gorilla itself we should look upon as a development of the Prot-simio-human on extreme troglodyte lines. Thus we cannot look upon the achondroplasic femur as a reversion to the Prot-simio-human femur. In all these cases the latter is far nearer to Recent Man than to this dwarf. In the case of the Rotular Index, which measures the height of the patellar surface relative to the distal articulation breadth, the Prot-simio-human femur is close to that of the advanced races—more than four times closer than to the achondroplasic femur. Thus the achondroplasic femur tends to diverge in the same sense as the Prot-simio-human from that of Recent Man in about half the indices dealt with, but it enormously exaggerates the tendency. The source of this appears to lie in the shaft in the first place, some dimensional indices of the epiphysis being that of Recent Man. The shaft of the achondroplasic femur has developed laterally, but failed in normal longitudinal development.

In the development of the primates we find in the *Simiadae* and the *Simiinae* increasing size of epiphyses relative to shaft. The massive epiphyses appear to be developed in the first place. This gives the troglodyte character to the epiphysial indices. Then comes rapid increase of the size of shaft, the dimensions of the epiphyses not increasing in the same proportion. In the direct human line this culminated in Cromagnon Man, with an exaggerated shaft and lessened troglodytism in the epiphysial indices. The later reduction of shaft in Recent Man has the appearance of a reversion towards the apes, for the epiphyses have not decreased in the same proportion. The Prot-simio-human represents a stage when the length of shaft was increasing at a greater rate than the epiphyses. The resemblance to this stage of the achondroplasic femur seems to arise from more or less stationary epiphyses accompanied by a reduction in shaft length to a value even less than that of the Prot-simio-human femur. Our table, p. 434, shows quite close equality in size of the Prot-simio-human and achondroplasic epiphyses, but the former is accompanied by a shaft on the evolutionary up-grade, the latter by a shaft on the pathological down-grade, *i.e.* by one the individual growth of which has been checked. According to the extent of this checking we conceive that achondroplasic femora still closer to that of our Prot-simio-human could be found. But if they were, we should not speak of the result as a reversion. We understand by a reversion the sudden appearance of a latent determinant reproducing in recognisable form the characteristic organ of an ancestor. In the case of the achondroplasic femur certain characters only of an organ bear excessively exaggerated simian values. If we are to consider this due to the release of hitherto latent simian determinants, we must confess that the result produced is a hopeless mish-mash of human and simian features—such a nightmare as might arise from ape and human hybridisation. It is not a reversion to an ancestral type which we can suppose ever existed.

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[1] Extreme robusticity is a feature of the non-adult or infantile femur: see for example Bumüller, Bibl. 81, S. 85 and our Plate LVIII. The shaft attains its transverse sooner than its longitudinal adult measurements.

There is another aspect from which the relation of the achondroplasic femur to reversion may be considered, namely the appearance of anomalies which are characteristic features of the apes. The particular femur we have had under consideration has (i) a well-marked crural trough, (ii) a lateral projection surmounted by a well-marked ridge form of third trochanter, (iii) from the base of this a rugous area running spirally on to the posterior face—somewhat resembling the *fossa angulolateralis* in the Gorilla, (iv) a non-identifiable popliteal apex, (v) a popliteal area convex and ill-defined, (vi) a very deep and extensive *sulcus M. poplitei* as in the Gorilla and Chimpanzee, (vii) a great trochanter rising above the head, (viii) a badly shaped head with a large triangular shaped *fovea*; the articular surface, which is a good deal lipped, is cut away on the top of neck and on lateral face, but extended a good deal anteriorly and posteriorly, (ix) a super-trochlear fossa on the anterior face, *i.e.* a deep groove where epiphysis unites to diaphysis, (x) a patellar surface which is V-shaped, rather than saddle-shaped, (xi) a complete absence of pilaster. With the exception of (ix) and (x) these anomalies are simian, but it seems to us that their appearance in the achondroplasic femur only illustrates the principle we have before appealed to, namely, that pathological bones tend to exhibit reversionary characters, and it does not indicate that the bone as a whole is a reversion to a definite ancestor, the Prot-simio-human.

Throughout this consideration of the distal epiphysis we have omitted to consider the Band-radial Index. This index is greater than 100 in Recent Man, it is approaching 100 in the Prot-simio-human, and is less than 100 generally in *Simiadae* and *Simiinae.* Greater stress has been laid on it as a test of upright gait by Bumüller than we believe it deserves[1]. Still, it is remarkable that to the best of our powers of measurement racial, ateleiotic and achondroplasic dwarfs exhibit Band-radial Indices markedly below 100. Now, the achondroplasic and occasionally the myxoedematous if not the ateleiotic dwarf do show poor uprightness of gait, but as far as we are aware this has not been observed in the racial dwarf, although certain of the photographs of Bushmen and Akkas suggest a tendency for the bones to turn inwards. Either, therefore, the point has been overlooked, as points often are when not directly suggested, or the excess of the Band-radial Index over 100 is not essential —as we incline to believe—to upright gait. Anyhow, with due reservation as to the difficulty of accurate measurement, the low value of the Band-radial Index appears to be a simiine feature of all types of dwarfs, and in this feature they greatly exaggerate the Prot-simio-human value.

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[1] Partly because we believe it to be over 100 in the *Cebidae*, and partly because it is very difficult to measure accurately.

(*f*) *Conclusions.* As a general conclusion to this brief investigation on the femora of racial and pathological dwarfs we would state that we find little evidence of either survival or reversional Prot-simio-human characters in the angles, general indices or indices of the shaft for either racial or pathological dwarfs. For the Proximal Epiphysis the Racial Dwarf does approach the Prot-simio-human, but the approach appears to be in those characters which are hylobatic rather than troglodyte. For the Distal Epiphysis the Racial Dwarf slips out; there is some resemblance to the Ateleiotic Dwarf in certain characters which depend upon relative exaggeration of the epiphysis in the latter, and thus produce troglodyte indicial values. We hold this is not a reversion, but solely due to the infantilism of the type. Again, although the Achondroplasic Dwarf exhibits in certain cases exaggerated simian characters, we believe these to be chiefly due to a failure in longitudinal growth of shaft and not to be Prot-simio-human reversions. There are certain characters in which the dwarfs are admittedly more simian than Recent Man, but we do not believe that any really substantial light can be thrown on the ancestry of Man by a study of the dwarf femur, whether racial or pathological in type.

CHAPTER X

COMPARISON OF THE FEMORA OF THE ANTHROPOIDS, OF PRIMOGENIAL MAN AND OF RECENT MAN

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To this Chapter belong three major Tables:

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(i) *Sources of Material and Criticism of its Value.*

In approaching this difficult subject we must stay to note that step by step we have been led beyond the initial scheme of our work—the study of the English femur—first to a consideration of the femora of other races of Recent Man, then to that of Primogenial Man and ultimately to those of a wide range of primates from *Tarsius* to the Gorilla. Nay, we can even add that we have gone further and examined in order to throw light on individual obscure points the femora of a great variety of mammals and birds. This extension of our topic has not been due to an incurable love of wandering far afield, but little by little we have been driven forward in the search for an explanation of those recurring anomalies in the human femur, which only too persistently indicated that they must be interpreted as vestiges of generic or at least specific characters in ancestral forms. There is not the least doubt in our minds now that in approaching our subject from the standpoint of the human femur, we began so to speak at the wrong end. Not only should we have known better what anomalies to look for in the case of man had we started with the lower primates[1], but we should have learnt at once that quite a number of the measurements taken by the anthropologist are unsuitable, very difficult to make or even impossible in the case of the lower primates. Further, we should have realised that other measurements not hitherto taken in the case of the human femur are essential when we come to a comparison of that femur with those of the lesser apes and lemuroids. Notably important in this aspect are measurements on the patellar surface. It was only after a study of the lemuroid and lesser ape femora that we realised the evolutionary importance of the shape of the patellar surface, and recognised that some half-a-dozen indices ought to be based on measurements of this surface. The real importance of a number of indices not usually determined by anthropologists also became evident, for example the Pithecoid Index and indices formed on the direct and oblique lengths of *both* condyles. The necessity for using a proportion of the diaphysial length in fixing the popliteal section, instead of the 4 cm. rule, becomes evident even when dealing with Primogenial Man and the Anthropoids, and *à fortiori* is still more manifest when femora range from those of the *Hapalinae* to those of men of the Cromagnon Type. Again a wide study of the primate femur indicates how little a platymeric index *taken in the subtrochanteric region* can serve as an interspecial measure of femoral flattening, for the maximum flattening may take place either on the level of the trochanter minor or even above it[2]. The measurement of the popliteal apex and the formation of the indices associated with it become idle for the apex is indeterminable below the Anthropoids and is mostly guess-work even in their case. Again, the measurement of the vertical diameter of the head requires further standardisation where the articular surface—as in certain lower primates—is extended considerably onto the top of the neck. In addition the definition of the Bicondylar Width is laid open to question when it is found that in some individual cases among the primates the distance from epicondyle to epicondyle is not the maximum breadth. Or, again, what must we say to our definition of the maximum femoral length as from bottom of internal condyle to top of head when it is found that the length from external condyle to top of head can actually be greater in the case of some apes? Clearly many of the purely anthropometric measurements would have been otherwise worded or wholly modified if they had been *ab initio* selected as suitable for determining the relative characters of all members of the primate group.

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[1] For example a posterior fossa is a recurrent feature of the femur of a considerable number of lesser apes. It is a phenomenon which might occur in human femora with but little pilaster and might then very easily be overlooked. We did not search for it directly in examining our long series of London femora and therefore are unable to say dogmatically whether it actually does or does not occur as an anomaly in Man. What we have termed a "frontal pilaster" occurs in certain Lemuroids, we have found it as an anomaly in the human femur, but we had overlooked it before our attention had been attracted to it in the lower primates. The extensions of the articular surface of the femoral head in man have quite a different weight and need much more precise localisation after we have recognised their relationship to similar features which are generic characters of some of the lesser apes. The above cases are by no means the only cases in which a previous study of the femora of the lower primates would have been serviceable.

[2] Even when the flattening is subtrochanteric the value of the Platymeric Index for comparative purposes may be small, if one species invariably has lateral protrusion or ridges of the third trochanter type. The effect of the third trochanter in exaggerating the transverse diameters of the shaft may be observed probably in most of the lemurs and certainly in quite a number of mammals as low down as the pilastric section.

We have accordingly had to make certain modifications of old measurements, to introduce certain new measurements and to calculate a number of new indices in dealing with the femora of the lesser primates. These will be discussed, as far as is needful, in an Appendix to a later part of this memoir dealing more at length with the femora of the primates, but as we are publishing with this part a considerable number of the measurements a brief warning on the point is needful.

Some words must, also, be said here as to the descriptions of the patellar surface provided in the "Remarks" to the table of measurements of the primate femur. We have already stated that this varies very widely in the different groups and provides generic if not specific characters. In a considerable number of the lemurs we find the articular surface consists of a long groove or tongue raised above the general level of the shaft and running a considerable distance up the shaft[1]. This tongue or groove is weakened in one of two ways, either it is shortened until it reaches a more usual primate length, or the tongue may exist with only partial traces of the articular surface remaining upon it, just as if it were only partially or occasionally in use as a bearing for the patella. The tongue and the traces of the articular surface may become so faint that one doubts whether it can be said to be there or not. We have certainly found traces of the tongue in some of the lesser apes, and with less assurance we think we have noted it in very rare cases in the human femur. It is obviously therefore of considerable interest to measure the height of the patellar surface, to note whether there are traces of the tongue beyond the usually assumed boundary of the patellar surface[2], and to observe the extent to which it stands in relief above the general level of the shaft. But the height of the patellar surface must be taken relative to the size of the bone and this involves the formation of an index. This index may be taken on the maximum length of the bone, or, since the tongue may run a long way up the shaft, it may be better to take it on the diaphysial length. Again the breadth of the patellar surface and especially its relation to the height is of significance, but it is extremely difficult to get a satisfactory measure of the breadth of the patellar surface which shall be a fairly homogeneous dimension for all primates. Ultimately we felt compelled to take the width of the articular surface of the condyles, a measurement which has at least the advantage that it can be compared with the measurements taken on the Rothwell femora by Parsons and on the Portuguese femora by Tamagnini and de Campos. The ratio of this breadth to the size of the femur can be calculated, and what is more interesting the ratio to the size of the bicondylar width. We have accordingly determined for the femora of all our primates the following additional characters.

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[1] Similar patellar surfaces occur in a number of other mammals; we are inclined to think that they may have association with some faculty for springing, and an inquiry into the habits of animals with long-tongued patellar surfaces might lead to points of interest.

[2] In certain cases the patellar surface is patchy on the tongue and it is impossible to fix a definite boundary to the articular surface. The height of the patellar surface was measured on all the smaller femora with a reading microscope, but very occasionally it seemed easier to determine its boundary with the naked eye than by the hair of the microscope.

(i) *The Height of the Patellar Surface.* The bone is adjusted in the reading microscope so that the motion of the microscope is along the axis of the shaft. The reading hair is first made to touch at the centre (mid-trochlear point) the mid-trochlear curve and then carried forward till it touches at the highest point the proximal contour of the patellar articular surface. The space traversed by the hair is read as the height of the patellar surface. It is clearly the maximum height projected onto the axis of the shaft. The height along the axis of the shaft is not taken, because, particularly in the case of man, it does not give the maximum height. It does so more nearly in the case of the anthropoids and lower apes, for which the patellar surface is more nearly symmetrical, instead of possessing the usual lateral extension of the human articular surface[1].

In the case of the larger femora, especially the human, a knife edge was fixed perpendicular to an osteometric board. The femur was placed in the standard position on the board with its anterior face upwards and its mid-trochlear point against the knife edge. A horizontal bar perpendicular to the shaft axis was made capable of sliding in the direction of the shaft from the knife edge to contact with the proximal contour of the patellar articular surface at its highest point. The distance through which the bar slides measures the patellar height, p_h.

(ii) *Width of the Distal Articulation.* We tried in vain to obtain a satisfactory measure in the manner indicated by Parsons[2], and the difficulty increased as we passed to the lower primates. We were therefore driven to define the width of the distal articulation to be the maximum width of this articulation taken parallel to the standard horizontal and vertical planes and between the lateral border of the articular surface of the external and the mesial border of the articular surface of the internal condyle (w_d). The following indices were then formed:

(iii) *Distal Articulation Ratio* $= 100\, w_d/a$, where a is the maximum length.

(iv) *Distal Articulation Index* $= 100\, w_d/s$, where s is the bicondylar width. The Distal Articulation Index ranges in the primates from 79 to 96. It is highest in the *Indrisinae* (93·2), *Ateles* (92·9), *Cynocephalus* (93·2) and the Orang (93·3); it is low in Primogenial Man (79·4 in Neanderthal Man), while Recent Man (89) has in this as in other characters reverted to the ape (Gibbon and *Cercopithecus* circa 90).

(v) *Rotular Ratio* $= 100 p_h/a$. The Rotular Ratio is very high in *Tarsius* (9·2), the *Galaginae* (9·1) and *Lemurinae* (9·9). It is high also in the Greater Anthropoids

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[1] We have not been able definitely to associate this human asymmetry with the exaggerated obliquity of the femur in man.

[2] Bibl. 111, p. 240. The measurement taken when the boundaries of the patellar surface are not parallel appears to depend on the thickness of the arms of the spanner. Our measurements for the Distal Articulation Width, ♂ 70·22, ♀ 62·25, are not comparable with Parsons' even after allowance has been made for the larger size of the Rothwell femora (♂ 74·90, ♀ 66·00, allowance made).

(7 to 8). It is low in Primogenial, especially Neanderthal Man (3·95), but Recent Man (5·7) has a value close to those of *Ateles* (5·75), and the Gibbon (5·7)—a gibbon-like human feature, but again probably a reversion.

(vi) *Rotular Index* $=100p_h/w_d$.

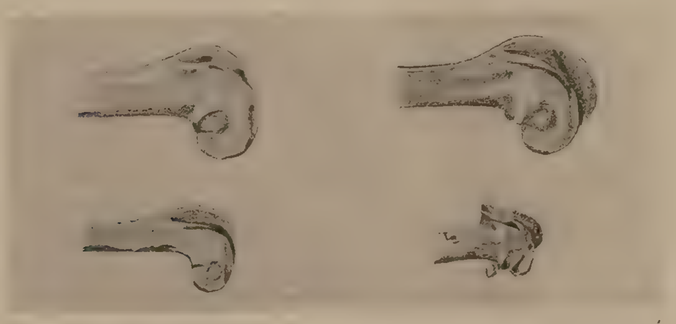
Tarsius (97) and Neanderthal Man (24) form two extremes. Recent Man (37) appears to have reverted from Primogenial Man towards more apelike values (Chimpanzee 39, Orang 42). *Hylobates*, fossil and recent, has a high value (48) which is more in keeping with that of the lesser apes. *Ateles* (38) on the other hand approaches the human value.

(vii) *Diaphysial Rotular Ratio* $=100p_h/l_d$, where l_d is the diaphysial length.

The conclusions to be drawn from this are very similar to those for the *Rotular Ratio*. The position of the *Lemurinae* (11·5), *Galaginae* (10·8) and *Tarsius* (10·6) at the head of the list is emphasised, Neanderthal Man (4·7) is still at the bottom, but Recent Man (6·7) is now somewhat differentiated from *Ateles* (6·1) and the Recent Gibbon (6·4), but not from *Dryopithecus* (6·6).

With regard to the elevation of the patellar surface above the shaft the conception of *relievo* is so natural that we have adopted its terminology. When the patellar surface is accurately level with the shaft as is usually the case in Man we term it *piano*; when it is in slight relief as in the Orang or occasionally in Man, it is *bas relievo*. The patellar surface of *Tarsius* is in high relief *alto relievo*; while medium relief *mezzo relievo* occurs in certain baboons, *e.g. Papio maimon*. The following cut illustrates the nature of such relief in the patellar surface.

Examples of Patellar Surface Relief.



Bas relievo

Mezzo relievo

Bas relievo

Alto relievo

We have described the patellar surface as "short" when it scarcely reaches to the height of the top of the condyles on the posterior face; as "medium," when it about reaches this height, and as "long" when it sensibly exceeds this height. (See the Remarks to the Measurements of the Femora of the Primates in Atlas, Part II.)

The above indications should suffice to justify our use in the present chapter of the indices of the patellar surface as discriminants in our search for the simio-human ancestor.

Before entering on a general discussion we should like to impress upon the reader that the material which we have been able to collect is rather a suggestion of what it is necessary to do, than a summary of what has been adequately done. We should be the last to lay overmuch stress on values obtained from casts and photographs or on the few measurements we have been able to obtain during the past few years on the anthropoid femora in the Laboratory itself. But the continuous war-work of the Director and Staff since August 1914 has hindered the completion on really adequate lines of the work started on a much more limited scale in 1895. As our interest and knowledge grew we purposed a complete measurement of all the anthropoid material available in British museums, and a continental visit to confirm or correct the measurements on the femora of primogenial man. Under war conditions the former has had to be postponed for an indefinite period, and the latter as far as the present writers are concerned is unlikely ever to be possible.

While admitting the temporary character of our determinations we should by no means have published them had we not considered that the accompanying tables, if the reader will only remember that they are not final ones, give more information and more reliable information in a single work than has hitherto been available.

At the same time considering the size of our sample we have been rather surprised to note how fairly closely our own measurements for the anthropoids accord with those of other writers. The present table of comparative results was printed at a fairly early stage, as we needed the information for reference in a concentrated form. We overlooked the anthropoid material in Antony and Rivet's paper of 1907. This gives: (*a*) the bicondylar width of 26 gorilla femora as 84·1; our value for five was 84·1, or when the two femora (B. W. = 101) of the gigantic Edinburgh gorilla of Hepburn are added, 88·9; (*b*) the bicondylar width of 19 chimpanzee femora as 65·8; the three chimpanzees of our table give 65·2. On the other hand they give (*c*) the ellipticity of the neck of 15 gibbon femora as 80·9. Our gibbon femora have an index of 73·9. We do not attribute this difference solely to the individuality of our sample. The diameters of the neck are characters which sadly need standardisation and, it has been our experience, are only of comparative value when measured by the same authority, or when practically identical methods have been employed in their determination. A comparison of the first and second columns under each anthropoid in the table will indicate to the reader the extent to which our measurements of isolated femora are in accordance with the more numerous series of other authors, when such are available. Measurements of anthropoid femora are in our experience very infrequent and are as a rule confined to certain very special characters; no writer, as far as we are aware, has hitherto published a complete series of measurements on any single anthropoid femur.

Passing to the femora of primogenial man we have been struck by the complete inadequacy of the descriptive memoirs of the great finds. This applies not only to the osteometric side, which has been sadly neglected, but even to the description of anomalies. It applies not only to early writers, such as E. T. Newton on the Galley Hill femur (1895)[1], Sir Richard Owen on the Tilbury femur (1884)[2], and Dubois on *Pithecanthropus erectus* (1894), to whose omissions we have frequently made reference, but to Marcellin Boule's great memoir of 1911—*L'homme fossile de La Chapelle-aux-Saints*—with all its splendid illustrations and refined technique[3], and in a lesser degree to Verneau's splendid volume on *Les Grottes de Grimaldi*[1]. Indeed Boule and Verneau do not provide as complete a system of measurements as Fraipont and Lohest did for the Spy femora in 1887[2]. As for Schaaffhausen in his account of the original Neanderthal find published in 1858[3], he tells us that two "ganz erhaltenen Oberschenkelbeine" were discovered, but only provides four measurements taken on one of them! Somewhat more complete measurements, of the accuracy of which, however, we are not entirely convinced, were taken by Klaatsch in the cases of *Homo mousteriensis* (*Hauseri*)[4] and of *Homo aurignacensis* (*Hauseri*)[5], but these leave many measurements to be added. Klaatsch in 1910 has also provided relatively the most complete set of measurements we have come across of the Neanderthal femora R. and L. and Spy I and II, but it is quite clear that his methods of measurement must have differed much from ours[6]. In 1910 Capitan and Peyrony announced the discovery of two human skeletons of the Mousterian epoch, but provided no details, which they then said were to follow[7]. We have not yet come across any detailed study.

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[1] The osteometric data provided are as follows: Maximum Length "about 419 mms." (16½ inches, which equals 419·1 mms.) in text, but as 421 mms. in table (Bibl. 69 *bis*, p. 509); Transverse Diameter "about 30 mms.," and Antero-posterior Diameter (avoiding *linea aspera*!) "above" 25 mms., both about middle of shaft; Length of Condyles, 62 mms.; V. Diameter of Head, 48·5 mms.; neck and shaft "at the usual angle." Neck said to be flattened and shaft stated to be nearly straight. We make the ellipticity of the neck considerable (69·6?) and therefore the index less than the human mean value (76). On the other hand we get very considerable bowing. The Primary Index of Bowing is 2·7 on the cast and 3·1 as obtained from Newton's own illustration (Plate XVI of his paper). It is clear that the osteometric value of Newton's paper is small.

[2] Owen's paper (Bibl. 33 *bis*) is still slighter in osteometric detail. He tells us that the "total length of bone," whatever this may be, is 16½″, the cast does not suggest that any "total length" could be found. The only other measurement given is "circumference" 3″, 9 lines. Noteworthy anomalies are, however, registered, namely a marked third trochanter and a considerable tubercle on the anterior face at the lower end of the intertrochanteric line. It will be remembered that W. Roger Williams (*Journal of Anatomy and Physiology*, vol. XIII. p. 212, London, 1879) considered two tubercles—the inferior and superior cervical tubercles—to be marked terminations of the *linea intertrochanterica*, the latter is now usually termed the tubercle of the femur, and the former is what Owen records on the Tilbury femur.

[3] To justify this criticism we refer to pp. 150—161, which are entitled *Fémurs*. We have endeavoured to extract the data for the La Chapelle-aux-Saints femur from these pages, but largely in vain. Boule gives us, it is true, the Maximum Length 430, the Pilastric Antero-posterior 31, and Pilastric Transverse 29, and the Index of Robusticity 14 (which may be compared with our values from his photographs). All the other values he gives are stated vaguely as means for 3 or 7 or 8 femora of the Neanderthal Type, and we often do not know which of these famous femora he has included, and how he has obtained his measurements for them. Thus, as example, we may cite "Quand on compare la longueur du col, comme la prennent la plupart des auteurs avec la longueur de fémur en position, on obtient *l'indice de longueur du col*....L'indice moyen de quatre fémurs de Néanderthal, Spy, La Chapelle et La Ferrassie est de 17·4." It appears to us that Boule is here not dealing with the length of the neck, but the length of the bust, *i.e.* with the Secondary Bust Index and not the Lemotic Index, nor does he indicate how widely femoralogists differ in "neck" measurement. Our mean value in the case of four femora of the Neanderthal Type is 17·45, agreeing well with his mean of three, but our value is obtained because the gibbon-like proportions of the Neanderthal femur in this index are counterbalanced by the gorilla-like proportions of the La Chapelle-aux-Saints femur. We have not Boule's own measurement of the "longueur du col" to confirm this point. Again the Platymeric Index of the La Chapelle-aux-Saints case is lost under the bald statement that "sa valeur moyenne, pour les fémurs fossiles est de 80." We make it on the average of four cases 77·6, and it actually would be considerably lower but for the high and unverified value of 85·1, which we have given to La Chapelle-aux-Saints. Again Boule tells us that the Pilastric Indices of seven Neanderthal Type femora give a mean of 99. He does not state which femora; we find it for four, using Boule's and not our own value for the La Chapelle-aux-Saints femur, 105·4. We are quite unable to say whether the difference is due to the femora chosen to represent the type, or to the values given to the indices in those femora. For the Collar Angle Boule gives the mean of six cases—not further specified—as 116°. We find the mean of four cases to be 115° in close agreement. But Boule does not state what is true if our measurement be correct; that while La Chapelle-aux-Saints agrees exactly with Spy and *Homo mousteriensis* (*Hauseri*) at 112°, it is the Neanderthal value of 123°·5 which really raises the average to 115°. He measures the bowing by the curvature method of Antony and Rivet and gives the mean radius of curvature as 72·4 for *seven* Neanderthalloid femora, without stating which or giving individual values. We could continue the

Such are the chief sources of the material for the study of the femur of Primogenial Man and the reader who will examine them from the standpoint of the needs of modern femoralogy, will not, perhaps, be surprised that under the recent war conditions we were driven to working on the photographs and the casts. This action also received support from the divergences we found between our measurements on the casts, and those of Fraipont and Lohest and again of Klaatsch. In the case of the latter authorities we must suppose them to have been measuring the originals, yet they are far from being themselves in complete agreement, and their values differ very considerably from our measurements on the casts. Some setting of the mould and some setting of the cast is of course certain, but the differences, especially of the angles, are greater than we should have anticipated. We hold that in large part, as in taking the platymeric, pilastric and popliteal diameters, there is

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list, but the above instances must suffice to serve as basis for our criticism. At the same time we find as a rule a very considerable degree of agreement between our mean values and those given by Boule.

[1] Bibl. 94 *quater*, see pp. 51—55, 61—62, 107—109, 154. Verneau gives the Maximum and Oblique Lengths, the two Platymeric, the two Popliteal and the two Capital Diameters, and the Bicondylar Width. In three cases he provides the breadth of the Distal Articular Surface. Of indices he calculates only the Platymeric and Popliteal (in the Table, p. 154, he gives the absolute measurements of the R. femur of the Grotte des Enfants subject, but they appear to be combined with the indices of that femur, although in the Table on p. 108 the values for both sides are provided). On p. 109 he gives the obliquity for two out of his eight femora, but does not state to which side of the individuals dealt with they refer. On the same page he says "l'angle cervico-diaphysaire varie de 109° à 117° chez nos sujets," but he does not state which values the individual femora have. This is the more vexatious as the individuals belong to such different types. It will be seen that the osteometric data provided by Verneau are very slender. We have added as many measurements as we could safely take from his illustrations. But these illustrations are limited to the anterior view of four and the posterior view of three of the nine or ten femora to which he refers.

[2] Bibl. 42 *bis*, pp. 651—656.

[3] Bibl. 5 *bis*, S. 457.

[4] Bibl. 101 *bis*, S. 287—297.

[5] Bibl. 103 *bis*, S. 273—338, and Bibl. 102 *bis*, S. 513—577.

[6] Bibl. 103 *bis*, S. 329 and *Anatomischer Anzeiger, Ergänzsheft zum XIX Bd.* 1901, S. 121—145.

[7] Bibl. 104, pp. 48—53.

divergence of method[1], and on that account we believe that until we can ourselves measure the originals, our cast and photograph measurements are more comparable with our other measurements—not necessarily better—than those of these authorities.

Our interest in Primogenial Man may be of two kinds; we may either discuss the characters which are considered anomalies in Recent Man, or we may feel our way toward evolutionary suggestions by comparing the series of measurements.

(ii) *Anomalies of the Femur of Primogenial Man.*

We can record the following of the anomalies:

Trochanter tertius. This is well developed in both femora of the Neanderthal Man, and in each of the single surviving femora of the Spy I and Spy II. According to Boule[2] the femur of La Chapelle-aux-Saints does not show a third trochanter, but the Neanderthalloid femur of La Ferrassie does. *Homo mousteriensis* (*Hauseri*) is defective at this point, and of *Homo aurignacensis* (*Hauseri*) we can find no record on this point. The Galley Hill femur has a well marked pilaster running up to a ridge followed by a nipple form of third trochanter. Verneau's Cromagnon specimen shows no third trochanter nor do his Negroid Type femora. It would appear therefore that the third trochanter is more or less characteristic of Primogenial Man of the Neanderthal Type, but wanting in the Cromagnon and Negroid Grimaldi Types. The third trochanter while anomalous in the anthropoids and lesser apes is characteristic of the Lemurs. The *fossa hypotrochanterica* is well marked in Neanderthal R., and is quite definite in Neanderthal L. and in Spy I and Spy II. According to Boule[2] it is not found in the La Chapelle-aux-Saints femur, but appears in La Ferrassie I. La Ferrassie II is defective at this point. Galley Hill has a slight hypotrochanteric fossa on the mesial side of the ridge preceding the third trochanter. The *fossa* also appears in all Verneau's femora whether of Cromagnon or Negroid Type[3]. *Homo mousteriensis* (*Hauseri*) is defective at this point. We may conclude that the *fossa hypotrochanterica* is usual in all types of Primogenial Man. This fossa is found in the Chimpanzee. There is subtrochanteric lateral protrusion of the anterior face in Neanderthal L. and Spy I. It occurs also in the original Cromagnon and in the Tilbury Femora. The

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[1] Thus Klaatsch appears to take the platymeric diameter just under the trochanter minor, while we seek for the minimum antero-posterior diameter in the subtrochanteric region and measure the transverse at this height according to Manouvrier's rule. Klaatsch takes the pilastric diameters in the "middle" of the shaft—without saying how the middle is to be determined. We take the maximum antero-posterior diameter, which is not always at, if near, the middle, and the transverse at the same height. Our method of finding the collar angle also differs, and probably other processes will differ in like manner. We can find a further illustration in the torsion:

	Neanderthal	Spy R.
Klaatsch	9°·5 (R.)	14°·0
Rodriguez	—	13°·5
Rivet	13°·0 (R.)	20°·0
Pearson	6°·0 (L.)	16°·0

It is clear that the methods used are divergent in the extreme!

[2] Bibl. 106 *bis*, p. 158.

[3] Verneau speaks of it as a great depression, which in some of his specimens was 50 to 55 mm. long. Bibl. 94 *quater*, p. 107. Boule states that it exists on all femora of the Cromagnon Type. Bibl. 106 *bis*, p. 158.

Galley Hill femur is defective but there is evidence for probably marked antero-lateral protrusion. It is indicated but less emphasised in *Homo mousteriensis* (*Hauseri*). It is slightly evident in La Chapelle-aux-Saints and La Ferrassie I. It is probably there in La Ferrassie II[1]. The lateral protrusion also exists both in Verneau's Cromagnon and in his Negroid femora. The reader will easily recognise this protrusion in the plates of our Atlas devoted to Primogenial Man. It is a well marked feature of the gibbon's femur, and is still more marked in the Lemuroids. Another pithecoid character is the relative height of head and great trochanter when the femur is orientated to the standard horizontal plane. In this case the trochanter of the gorilla's femur outtops its head, while that of the Chimpanzee is on the same level. In the bulk of normal human femora the head is considerably above the level of the top of the great trochanter. In *Homo mousteriensis* (*Hauseri*) there is an approach to the Chimpanzee level (see our Plate XLVII). In La Chapelle-aux-Saints the great trochanter is relatively high[2]. In Ferrassie I the great trochanter appears to outtop the head[3]. This again seems to be approached in Verneau's Grimaldi negroid old woman, and the trochanter is, relative to the head, much higher in his Cromagnon Type femur than is usual in Recent Man[4]. Our Plate LI indicates the same feature in Neanderthal L. The defectiveness of the Spy femur hinders any judgment on the point. It is a marked feature of many of the Lesser Apes and the Lemuroids. On the other hand the Orang resembles Man in having the head markedly higher than the great trochanter. *Pithecanthropus erectus* does not show this pithecoid femoral characteristic (see our Plate XLVI).

The crural trough is to be noted in several of these fossil femora. In Galley Hill it is short longitudinally, but very broad. There is a marked crural trough in the original Cromagnon, and crural depressions in Neanderthal and Spy. In Verneau's material to judge by his photographs it also probably existed in the Cromagnon Type femora.

There is a wide short trough in Ferrassie I[5]. It is difficult to judge of La Chapelle-aux-Saints and the *Homo mousteriensis* (*Hauseri*)[6] as they have been restored in this neighbourhood. *Pithecanthropus erectus* appears to have a well marked trough. Another feature which Primogenial Man shares with Gorilla and Chimpanzee is the horizontality of the proximal border of the neck when the bone is orientated to standard horizontal and vertical planes. This is marked in *Homo mousteriensis* (*Hauseri*), in La Chapelle-aux-Saints, in La Ferrassie I, in the original Neanderthal, and in Spy I as restored by Boule. It is not true of Recent Man, and in this respect *Pithecanthropus erectus* may be said to resemble either Recent Man or the gibbon according to our bias. It is true of both Verneau's Cromagnon and Negroid Type femora.

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[1] Bibl. 106 *bis*, Plate IV, Figs. 3 and 3 *a*; also Fig. 78, p. 156 and Fig. 79, p. 157.

[2] Bibl. 106 *bis*, Plate IX.

[3] Bibl. 106 *bis*, p. 157, Fig. 79 and his remarks in text.

[4] Bibl. 94 *quater*, Plates X and XI.

[5] Bibl. 106 *bis*, Fig. 78, p. 156.

[6] Possible suggestion of a trough.

According to Klaatsch the cylindrical form of the shaft is maintained closer to the distal end of the femur, in the case of Primogenial Man, than in Recent Man. For Recent Man we have a more trumpetlike shape of the distal end of the shaft[1]. We have already reproduced (p. 10) Klaatsch's illustrative diagram. Boule also lays stress on this point and finds in it a closer resemblance of Primogenial Man of the Neanderthal Type than of Recent Man to the monkeys and *Pithecanthropus erectus*. Now this is a point where we have already indicated that we consider, not description, but actual measurement is in the right place. For this purpose we introduced the Soffit Index, and the Index of Gracility (Lower) is also of value. Let us take the latter first:

SUBTABLE I. *Index of Gracility* (*Lower*).

Anthropoids	Gibbon (4)	84·8	84·8
	Chimpanzee (3)	77·9	74·9
	Orang-utan (3)	73·7	
	Gorilla (10)	73·2	
Pithecanthropus erectus		76·7	76·7
Primogenial Man (Cromagnon Type)	Cromagnon	81·2 ?	75·8 ?
	Tilbury	81·2 ?	
	Verneau: La Grotte des Enfants L.	63·1 ?	
	,, La Barna Grand L.	67·6 ?	
Recent Man	17th century Londoners ♂	71·04	70·9
	,, ,, ♀	70·75	
Primogenial Man (Neanderthal Type)	La Chapelle-aux-Saints R.	77·8 ?	70·3
	Neanderthal L.[2]	75·9	
	Spy I R.[2]	69·9	
	Homo mousteriensis (*Hauseri*)	57·6	
	Galley Hill	58·9	65·8 ?
	Homo aurignacensis (*Hauseri*)	72·7	
Grimaldi Negroid Type	Old Woman	70·5 ?	58·0 ?
	Youth	45·5 ?	

Now a special point to be noted is the great range in the individual groups. But if we can trust the mean value the Neanderthal Type of Primogenial Man so far from approaching the anthropoids in the cylindrical character of the lower half of the femur is as gracile as Recent Man. The Cromagnon mean is based on absolutely opposed components, every one of which is of doubtful validity, for we have had to determine them in the first two cases from the casts of the defective bones and in the second case from Verneau's illustrations. The mean, if it shows anything, indicates that the Cromagnon Type was more pithecoid in this respect than the Neanderthal Type. Galley Hill is more gracile than the average of Recent Man, but Hauser's sample of Mousterian Man is still more gracile, and both these femora are more gracile than Hauser's Aurigniac Man which Klaatsch dubs of "orangoid" gracility. The fact is that "gracility," when expressed numerically, may be less for one feature of Orang and Aurigniac Man than it is for Gorilla and Neanderthal Man, while it far exceeds it in a second. A general description of the femur of one type as more gracile than another carries us very little onward unless we have defined gracility and actually measured it for a variety of characters. Galley Hill with the present criterion is a "gracile type," but then it has to us the appearance of post-mortem erosion along the centre of the shaft, or at least of ante-mortem feebleness[1]. Verneau's Grimaldi Negroid Type is the most gracile femur of all, if it were legitimate to club the "Adolescent" with the "Old Woman"—a doubtful enough procedure, and not justified by the modern negro femur being especially gracile[2].

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[1] Bibl. 87, S. 662.

[2] Values for this Index deduced from Klaatsch's measurements (*Anatomischer Anzeiger, Ergänzsheft zum XIX Bd.* 1901, S. 128 *et seq.*) are wholly different. But then his measurements of the popliteal widths are markedly different from ours. He gives for popliteal widths, Neanderthal L. 37 and Spy I R. 36, as against our 40·6 and 42·9!

Our general conclusion must be that the cylindrical or pithecoid character claimed by Klaatsch and Boule for the Neanderthal Man lacks quantitative demonstration. It is possible, however, that it is optically produced by the distal epiphysis being relatively large as compared with the lower portion of the popliteal area. In other words that the trumpetlike impression of the distal portion of the femur is produced by carrying on the walls of the trumpet into the distal epiphysis, while an enlarged epiphysis cuts off the trumpet at the end of the popliteal area. This is a point which the Soffit Index should properly test. The table on the following page indicates the data we have been able to collect.

[1] It may be as well here to give our views on the Galley Hill femur. We came to it with considerable prejudice owing to the uncertainty of its geological records, and the manner in which the find has been used for wide-sweeping conclusions based on little accurate measurement. A careful examination of the femur has, however, convinced us that it possesses many signs of great antiquity. It is not the single factors, but the combination of them, which should be emphasised. There are signs of marked muscularity, the coexistence of third trochanter, hypotrochanteric fossa, and crural trough, the remarkable trochanteric flatness and marked antero-lateral protrusion, marked supra-condylar eminences on both sides, convexity of popliteal area, all features which, occurring more or less isolatedly in Recent Man, are relatively rare when combined. The great trochanter and parts of the head having been broken off, make the proximal epiphysis now *appear* much more slender than it really was. It is impossible to judge accurately of what the original massiveness of the condyles may have been for they have largely disappeared. If the cast be placed alongside that of Hauser's Mousterian Man, it is by no means obvious that the Galley Hill was of a different type. Its head and condyles if completed would probably not have been markedly smaller, and it has the same exaggerated gorilloid form of neck. It has a more marked pilaster and is more slender in the pilastric region, if that be not due to post-mortem causes. In these respects it is more modern. We have just seen that it is not more gracile in the distal portion of the shaft. It might well be a small and pathological specimen of the Neanderthal Type. It carries the combination of anomalies we have occasionally found in what would be described as feeble or pathological specimens of recent femora which may well be reversions. It may, we think, be placed according to individual judgment either as a link between Neanderthalloid and Recent Man, but nearer to the former, or as a feeble or pathological specimen of the former. On any careful examination it could not be placed as a femur of Recent Man in the same sense that the Trinil femur would undoubtedly have been placed, had it not been found associated with the cranium of *Pithecanthropus erectus*. We are with those who claim true antiquity for the Galley Hill find, but we cannot agree with them in considering the femur as identical with that of Recent Man, nor in classifying it with *Homo aurignacensis* (*Hauseri*). We think Klaatsch has exaggerated the correspondences and neglected many of the divergences between the two: see Bibl. 103 *bis*, S. 328 for Klaatsch's views.

[2] It is also shown on our p. 303 that the Index of Gracility (Lower) increases with age, which probably accounts for the low index of the adolescent.

The table presents points of interest. In the first place we lay no stress on the position of Verneau's Grimaldi Negroid Type. It is acquired solely by the high values in the case of the "Adolescent." The "Old Woman's" femur has a value close to that of Recent Man. It may be indeed merely an indication of growth-change, the Adolescent having a Popliteal transverse Diameter relatively great as compared with the Bicondylar Width[1]. The main feature of the table is the manner in which Primogenial Man and Recent Man divide the Anthropoids. In the Gorilla the Popliteal Width is 57 %, in the Gibbon only 43 %, while in our 17th century Londoners it is 50 % of the Bicondylar Width. Cromagnon Type stands between the Gorilla and Recent Man, and the Neanderthal Type between Recent Man and the Gibbon. We thus find confirmation of the view that the less trumpetlike shape of the Neanderthal Type is an optical effect produced by greater relative width of the distal epiphysis. In this character, as far as we can judge in the defective state of the Galley Hill femur, that femur is separated from Hauser's Aurigniac Man by both Recent Man and Neanderthal Man. *Pithecanthropus erectus* lies between Recent Man and the Neanderthal Type. But here we must at once state that any argument based on the position for one character of a *single* individual of a race is of very little value. As far as this character is concerned Galley Hill might be a variant of Recent Man or of Cromagnon Man or of Neanderthal Man, and *Homo aurignacensis* (*Hauseri*) might be a variant of Recent Man or of Neanderthal Man.

SUBTABLE II. *Soffit Index.*

Primogenial Man (Grimaldi Negroid Type)	Old Woman (1)	48·1	54·4
	Adolescent (1)	60·8	
Anthropoids (A)	Gorilla (7)	56·7	52·15
	Orang-utan (3)	47·6	
Primogenial Man (Cromagnon Type)	♂ La Grotte des Enfants R.	54·44	52·00
	,, ,, L.	51·65	
	♂ Baonesso de Torre I R.	51·65	
	,, ,, ,, L.	48·42	
	,, ,, II R.	53·06	
	,, ,, ,, L.	52·75	
Galley Hill Man		50·9 ?	50·9 ?
Recent Man	17th century Londoners ♂	49·99	50·43
	,, ,, ♀	50·86	
Pithecanthropus erectus		46·2	46·2
Primogenial Man (Neanderthal Type)	*Homo mousteriensis* (*Hauseri*)	49·8	45·78
	Spy I	45·8	
	Neanderthal L.	45·3	
	La Chapelle-aux-Saints	42·9 ?	
	La Ferrassie I	45·1 ?	
Aurigniac Man	*Homo aurignacensis* (*Hauseri*)	45·3	45·3
Anthropoids (B)	Chimpanzee (3)	44·4	43·6
	Gibbon (3)	42·8	

It does not seem to us then that the claim to a "cylindrical" shaft as a special feature of the Neanderthal Type is very well founded.

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[1] Modern Negroes, see our p. 306, have a Soffit Index of 45; this is not gorilloid, but on the contrary gibbonlike.

A further anomaly noted by Boule and stated by him to associate the Neanderthal Type rather with the *Cynopithecidae* than the Anthropoids is the circular rather than triangular[1](!) shape of the pilastric section. This matter will be best considered when we deal with the Pilastric Index.

Boule, like Bumüller and Klaatsch, considers the problem of the relative size of the condyles. Following Bumüller he says that (i) in Man the External Condyle is larger than the Internal Condyle, (ii) that in the Apes this is reversed, (iii) that in Primogenial Man there is equality of the condyles[2], (iv) that in certain of the inferior apes they are also equal. On the basis of these statements Boule suggests that Primogenial Man is closer in this character of the condyle to some of the inferior apes than to the anthropoids. In reference to this matter we would point out that (*a*) the condyles are extremely nearly equal on the average in Recent Man, the Condylar Lengths Index being 100·5 : see our p. 407. There is no adequate evidence at present to show that they are more nearly equal in Neanderthal Man. On the contrary we find the Condylar Lengths Index = 110·7 for primogenial man of this type. This is markedly in excess of the anthropoids (81 to 97) and approaches more nearly the value in *Semnopithecus* (103) and *Dryopithecus rhenanus* (105). The majority of the *Simiadae*, however, have low values under 100. In the majority of *Cebidae* and the Lemuroids it exceeds 100, being as high as 111·4 in the *Indrisinae* and only really low in the *Lorisinae*. It would be better therefore to say that Recent Man is nearer to *Cercopithecus* and *Semnopithecus* than to the Anthropoids, and that Neanderthal Man finds his nearest approach in certain of the *Cebidae* (*Hapalinae*, 106) and the Lemuroids, *i.e.* is still further removed than Recent Man from the Anthropoids. It is a grave misfortune that we have no condylar lengths for either Cromagnon or Grimaldi Types, and that the condyles of Galley Hill are very defective. Even the Neanderthal values are not very certain. Still it is fairly clear that, as far as Recent Man is concerned, we can (*b*) add another to the considerable number of cases in which Recent Man is closer to the lesser apes than to the anthropoids, and (*c*) it is by no means yet demonstrated that this closeness is as great in Neanderthal Man, unless we go back to considerably more primitive primate forms. This question can hardly be properly discussed, however, until far more elaborate biometric studies of the femora of the lesser apes have been made than at present exist[3].

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[1] Hrdlička has published a paper (Bibl. 84 *bis*) asserting that the triangular shape is the fundamental form of the shaft in all the human long bones. We venture to differ from this view. The rotiform section seems earlier in the femur in man and the pyriform to be later. It appears to us not impossible that the rotiform section of certain of the lesser apes developed on the one hand into the maliform of the anthropoids and through the rotiform of the Neanderthal Type to the pyriform of Cromagnon. Nor can we at present accept Hrdlička's argument which appears based on change of shape of bone being due to muscular activities.

[2] Boule seems (Bibl. 106 *bis*, p. 160) to base his statement on the equality of the condyles in La Ferrassie II.

[3] Of anomalies which occur in Recent Man, but are not general in Primogenial Man, Boule notes facets prolonging the articular surface of the head onto the neck on the *anterior* face in the case of both La Ferrassie femora (Bibl. 106 *bis*, p. 156), and on La Ferrassie I a prolongation of the upper posterior surface

A last anomaly of the femora of Neanderthal Type to which we may briefly refer is their marked Bowing. This they seem to share with the Cromagnon Type. With the exception of the nearly straight femur of the gibbon, the anthropoid bowing is greater, but only slightly greater, than that of Recent Man, but the Bowing of both main types of Primogenial Man is very considerable, and should, we think, be associated with the progress towards a more perfect vertical gait. Some most exciting evolutionary problems must be associated with the development of the massive pilaster in the tall Cromagnon Race, but the appearance of this pilaster was not contemporary with a disappearance of the excessive bowing. It would at times almost appear as if a new and advantageous character had to be fully developed or even developed in excess, before a marked characteristic of an earlier kind tended to disappear. In any long series of femora isolated almost pathological individuals will be found with marked bowing and emphasised pilastry. It has been even suggested that the existence of a large amount of bowing tends to produce on the compression side of the strut the actual growth of the pilaster[1]. The question then arises: How is the pilaster preserved as a racial character while the bowing is reduced to much more moderate proportions? The mechanical origin of the pilaster seems to fail when we observe it associated with relatively straight shafts. The believer in the inheritance of acquired characters will find, perhaps, small difficulty in dropping the excessive bowing after the pilaster has been acquired. In Mendelian language the factor for the pilaster may have been acquired, but we should hesitate to believe that in femora of the Cromagnon Type it was not congenital, but acquired by use. They are certainly in no way pathological femora. We ourselves give little credence to the pure mechanical origin of either bowing or pilaster. Granted, however, the release or acquirement at a given epoch of a factor for pilastry, how was the factor for extreme bowing, at first associated with it, lost? The problem appears to be rather akin to some of those with which Morgan has recently been dealing. The existence of a character A, the possibly rather abrupt appearance of a second character B, the association of A and B for a period, and then the disappearance or partial disappearance of B[2].

In the following table we have added various cases of Primogenial Man to our earlier bowing material. We have already criticised Antony and Rivet's method of dealing with Bowing. Unfortunately while it is possible from our measurements to obtain the radius of pseudo-curvature, it is not possible from Antony and Rivet's mere

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of the lateral condyle of the left femur (*l.c.* p. 159). To the latter facets Havelock Charles has drawn attention: see our pp. 104—6.

[1] These apparently pathological femora, combining marked bowing and pilastry, may be considered by some as reversions, and indeed not the less so because they may be pathological, for we incline to the view that defective and feeble organs have *sui generis* a tendency to exhibit as anomalies reversionary characters.

[2] It should be clearly grasped what the supporters of the mechanical theory have got to account for: (a) marked bowing causes the development of a marked pilastry, (b) such marked pilastry has got to be inherited, (c) being inherited it checks the excessive bowing. (a) and (c) are possibly conceivable on mechanical grounds, the difficulty is in appreciating how (b) comes about. No doubt the cells on the

statement of that radius to obtain either of our Indices of Bowing although they must have taken our Diaphysial Chord and Subtense without, however, publishing the record of them. We are therefore compelled for any comparative purpose to deduce Antony and Rivet's pseudo-curvature from our measurements. We have introduced it in the last column but one in order to increase the data for gorillas and gibbons. But the disadvantages of using the pseudo-curvature—we have already commented on the disadvantages of this and Antony and Rivet's radius of curvature: see our pp. 276—9—are clear on examination of this column. Instead of a marked difference in bowing between the Neanderthal and Cromagnon Types, we find a near equality in the pseudo-curvature, while the larger anthropoids have a greater pseudo-curvature than primogenial man with far less bowing. The simple explanation of these anomalies is that if we magnify a femur n times, we obviously do not alter the amount of its bowing, we are merely modifying the scale on which we choose to examine it, but we increase its pseudo-radius of curvature n times and decrease its pseudo-curvature to $1/n$th of its previous value. Hence as the Cromagnon Type is

SUBTABLE III. *Table of Indices of Bowing and Femoral Curvature*[1].

Race	Individuals	Primary Index of Bowing		Secondary Index of Bowing		Pseudo-curvature in cm.$^{-1}$		Pilaster
Primogenial Man (Cromagnon Type)	Cromagnon	4·08	4·25	41·5	43·1	·0118 (1)	·0127	Exaggerated
	Tilbury	4·43		44·7		·0137 (1)		
Primogenial Man (Neanderthal Type)	Neanderthal	4·19	3·69	58·2	53·45	·0132 (1)	·0122	Slight
	Spy	4·14		48·9		·0138 (1)		
	Homo mousteriensis (*Hauseri*)	3·84		54·2		·0151 (1)		
	La Chapelle-aux-Saints	2·58		52·5		·0069 (1)		
Pithecanthropus erectus	... ...	2·82?	2·82?	48·7?	48·7?	·0081? (1)	·0081?	Present
Anthropoids (i)	Gorilla (5)	2·91	2·75	50·2	49·3	·0136 (33)	·0125	Absent
	Chimpanzee (1) ...	2·67		40·8		·0128 (20)		
	Orang (1)	2·66		49·8		·0082 (5)		
Galley Hill ...	... ...	2·67	2·67	67·1	67·1	·0081 (1)	·0081	Well-marked
Recent Man ...	17th century Londoners ♂ (476)	2·55	2·53	36·85	39·0	·0096 (476)	·0096	Well-marked
	17th century Londoners ♀ (361)	2·50		41·13		·0097 (361)		
Anthropoids (ii)	Gibbon (1)	0·51	0·51	62·6	62·6	·0052 (16)	·0052	Slight

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posterior face of the bone may have learnt a new habit, but they are not germ cells, and the vigorous language of Adami (*Medical Contributions to the Study of Evolution*, London, 1918; especially pp. 132—160) does not help us to ascertain how they are going to modify the germ cells. Darwin's theory of pangenesis would do so, but since Galton's crucial experiments on transfusion (*R. S. Proc.*, Vol. XIX. pp. 393—410) cast discredit on the blood as the bearer of the gemmules it is very difficult to accept that theory. The appearance of a new factor leading in some manner to the dwindling of an older and closely associated factor suggests a more hopeful path of inquiry and transfers the problem from gross to cytological mechanics.

[1] The anthropoid femora available when this table was constructed were those of the folding table, Table I, p. 450 of this chapter, not those of the complete table of the Atlas, Part II, summarised in folding Table III of this chapter.

absolutely larger than the Neanderthal Type, and that type larger than that of the greater anthropoids, erroneous conclusions must be drawn when curvature is used as a measure of bowing, and this will be quite apart from the error introduced by the fact that the curvature of the diaphysial arc is far from constant. If we confine our attention to the Primary Index of Bowing, the bowing increases from Greater Anthropoids to Neanderthal Type and still more to Cromagnon Type, but it falls in Recent Man. This is precisely the case also with the pilaster, the series being: absent, slight, exaggerated and then a fall to well-marked. In pilaster Recent Man is nearer to the gibbon and some of the lesser apes than to the Greater Anthropoids. In shape of pilastric section we pass from maliform (Greater Anthropoids) to rotiform (Neanderthal Type), to pyriform (Cromagnon Type), while Recent Man has a less exaggerated pyriform section and frequently tends to more rotundity. In Bowing *Pithecanthropus erectus* is simply human if we can trust our queried value. Bowing gives no confirmation of the *Hylobates giganteus* theory, for the Gibbon[1], judged by the Primary Index or by the Pseudo-curvature, is widely divergent from man in any form. In both Bowing and Pilaster Galley Hill appears to stand nearer Recent Man than to Neanderthal Man. If our values for the indices be, however, correct, Galley Hill is more bowed than La Chapelle-aux-Saints. A curious point about Galley Hill is the low position as judged by the Secondary Index of Bowing of the point of maximum bowing, it is almost at the distal third point of the Diaphysial chord. About the proximal third point, however, the anterior face of the Galley Hill shaft is somewhat broken away. We very carefully plotted point by point the anterior face from the cast, and it seems to us that in the neighbourhood of the proximal third point there are signs of contra-flexure apart from the defective area, and this tends to support the view that the feebleness of the shaft in this neighbourhood is not natural but due to post-mortem injury, or ante-mortem pathological condition. The point of maximum bowing is about the middle of the shaft for the *larger* anthropoids (a little above the distal third point in our specimens of gibbon!); it falls just below the midpoint of the shaft in Neanderthal Man, but rises markedly in Cromagnon Man, and reaches the $\frac{2}{5}$ths point in Recent Man. To grasp the significance of these changes would need far fuller data than we yet possess, and a far more comprehensive study, leading to a clearer knowledge, of the functional services of bowing in the femur. Our table, however, suffices to indicate that Bowing can hardly be looked upon as an anomaly; it is a racial character, which has been developed as any other racial character, in the evolutionary process, and may, as knowledge increases, be an important element in determining the evolutionary order.

We have seen (p. 283) that Bowing is intraracially significantly, if not very markedly, correlated with the Pilastric Index. Interracially we failed on p. 282 to find any association between Pilastric Index and Curvature. If we arrange our present material in order of Pilastric Index we have:

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[1] *Dryopithecus rhenanus* with Primary Index 0·6 is what we should anticipate in *Hylobates giganteus*—*i.e.* scarcely any bowing.

SUBTABLE IV. *Index of Bowing and Pilastric Index.*

Race	Individuals	Pilastric Index		Primary Index of Bowing	
Primogenial Man (Cromagnon Type)	Cromagnon	125·2	125·1	4·08	4·25
	Tilbury	125·0		4·43	
Primogenial Man (Neanderthal Type)	La Chapelle-aux-Saints	117·9	108·1	2·58	3·69
	Spy	107·7		4·14	
	Homo mousteriensis (*Hauseri*)	104·6		3·84	
	Neanderthal	102·3		4·19	
Pithecanthropus erectus	...	108·7	108·7	2·82?	2·82?
Recent Man	17th century Londoners ♂	104·4	103·0	2·55	2·53
	„ „ ♀	101·6		2·50	
Galley Hill	...	99·2	99·2	2·67	2·67
Anthropoids (ii)	Gibbon	95·0	95·0	0·51	0·51
Anthropoids (i)	Chimpanzee	84·3	80·4	2·67	2·77
	Orang-utan	80·0		2·66	
	Gorilla	77·1		2·91	

It will be clear that our failure to find a relation between Pilastric Index and Bowing was not solely due to the use of curvature (p. 282). It was of course partly due to the curvature displacement of Gorilla. But when we use the Index of Bowing we still find that the Greater Anthropoids do not fit into the series. *Hylobates*, Recent Man, Neanderthal Man, Cromagnon Man, form a series in which the Pilastric Index and the Index of Bowing both ascend, and interracially there is high correlation of Pilastric and Bowing Indices[1]. This result seems to indicate that at any rate in Man and the Lesser Apes there is a close association between Bowing and the development of a high Pilastric Index. But we must not extend the principle to the Greater Anthropoids for with a low Pilastric Index they have more Bowing than Recent Man. We see, however, the weakness of the Pilastric Index as a measure of the pilaster, for the common order of the two indices is not the order of pilaster development. It gives

Cromagnon Type	125·1	Pilaster	exaggerated
Neanderthal Type	108·1	„	slight
Recent Man	103·0	„	well-marked
Hylobates	95·0	„	slight
Greater Anthropoids	80·4	„	absent.

The fact is as we have indicated on p. 255, the Pilastric Index does not distinguish between rotiform sections like those of the Neanderthal Type and pyriform like those of Recent Man, if their antero-posterior and transverse diameters are nearly equal.

If we want to pass from the slightly maliform pilastric section of the gibbons or the almost perfectly rotiform section of many of the *Cynopithecidae* to Recent Man, we have got to increase the Pilastric Index and also develop the pilaster from slight to well-marked. The pilaster remained slight in Neanderthal Man, but the Pilastric Index was raised; in Cromagnon Man the Pilastric Index was still further raised and an exaggerated pilaster developed—the pilastric section was markedly pyriform. Recent

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[1] Of order ·89 ± ·26.

Man has fallen closer to the Lesser Apes in Pilastric Index, but has retained the pilaster in a well-marked, if not exaggerated form. In other words the pilastric section has remained pyriform, but the transverse pilastric diameter has somewhat increased, relative to the antero-posterior. It is quite possible to hold that both Primogenial men of the Neanderthal and of the Cromagnon Types are side branches and not on the direct line to Recent Man, as we may still more reasonably suppose the Greater Anthropoids to be. But somewhere on the direct line individuals must have existed with pilastric index increased beyond that of the Lesser Apes and with well-marked pilasters, as the branching points from which Neanderthal and Cromagnon Man sprang off. These individuals have yet to be found. Those who would place the Trinil Femur in the direct line of Man's ascent certainly get over the difficulty of explaining how Recent Man has developed a high Pilastric Index and a pilaster. They seem, however, to forget that it will be needful then to account for the development on side tracks of Neanderthal and Cromagnon Man from *Pithecanthropus erectus.* The task presents no smaller difficulties than supposing Primogenial Man a stage towards Recent Man[1].

To sum up the conclusion suggested by this discussion of the anomalies of the femur in the case of Man, we may state that the anomalies which occur occasionally in Recent Man are to a great extent signs of a far grosser and more muscular member. Such a femur exists in the case of both the Greater Anthropoids and of Neanderthal Man, but the anomalies we refer to are almost usual in the latter, and such a marked feature of the former as the complete *fossa angulolateralis* has never yet been found even as an occasional anomaly in Man. On the other hand the well-marked pilaster is found neither in the Greater Anthropoids nor in Neanderthal Man. It is found in Cromagnon Man and in an exaggerated form. In a slighter form it is found in the Gibbon and in some of the Lesser Apes. If we suppose the direct human descent, as seems highly probable, never to have passed through any of the Greater Anthropoids as we know them but to pass directly to some simio-human form somewhat more akin to the lesser apes, we ask, are the Neanderthal and Cromagnon Types to be considered as branching failures from the main line of descent or as actual stages upon it? If the former we leave unexplained the occurrence of anomalies in Recent Man which point to an extremely muscular ancestry. We are almost bound to insert something very like the Neanderthal and Cromagnon Types in the direct line to account for the appearance of these anomalies, for the marked bowing and the well-marked pilaster of Recent Man. If we insert these links into the main line, the Neanderthal and Cromagnon Types will differ somewhat from them, but not very widely, and therein lies, as far as the Neanderthal Type is concerned, the justification, if any, for Schwalbe's view that the discussion of whether the Neanderthal Type (and we might add the Cromagnon Type) is or is not in the direct line is not of much worth. As far as the anomalies of the femur of Recent Man go, if Neanderthal and Cromagnon are not in the direct line, we have still got to insert some links very like them between the Prot-simio-human with a probable lesser apelike and lemuroid ancestry and Recent Man, and then those links remain yet to be discovered.

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[1] Verneau (Bibl. 94 *quater*, p. 316) states that the races of Spy and Grimaldi are parallels derived from *Pithecanthropus erectus.* If this view were correct the femur of man was completely developed while his cranium remained most primitive; then followed a development in which many of the femoral features of Recent Man disappeared in the Spy parallel. Did Recent Man recover them as a descendant of the Neanderthal Type or would Verneau suppose him a third parallel from *Pithecanthropus erectus,* which retained nearly all the characteristics of the femur, but widely modified the cranium? The dilemma might, perhaps, be solved by separating Trinil femur and cranium.

Klaatsch, possibly carried away by the differences he observed between two individual cases of Mousterian Man and Aurigniac Man, has postulated a double ancestry for man, a "gorilloid" and an "orangoid" origin. It is not very clear from his writings on the subject[1] whether he supposes Primogenial Man of the Neanderthal Type to be descended from a gorilla and of the Aurigniac Type from an orang. If we put his view, not in the form of ancestry, but in the form of a resemblance, the femur of the Neanderthal Type is to the femur of Recent Man as the femur of the gorilla is to the femur of the orang, or again we might add as the femur of the Pekinese Spaniel to that of a Pommeranian dog, there appears somewhat more truth in the proposition[2], at least ocularly. But when we come to the detailed numerical study of the femoral characteristics as in our last chapter, we find so many cases in which Recent Man actually separates both of these anthropoids from man of the Neanderthal Type that our faith in the suggestiveness of the proportion, and with it the strength of the argument for side tracking of the Neanderthal Type, are very much weakened. The reader should bear this point in mind in the summary of the results of that chapter as far as concerns Primogenial and Recent Man that we have now to place before him.

(iii) *Comparison of quantitatively Measured Characters in the Apes, Primogenial Man and Recent Man.*

(*a*) *General Remarks.* In dealing with this topic it seems by far the wiser course to group the anthropoids as far as possible together, to cite merely the means of our slender data for Neanderthal and Cromagnon Types and to represent Recent Man in the main by our 17th century Londoners; for in that case only have we adequacy of material for *all* the characters we propose to consider.

Before we enter into a full discussion of our topic, it is desirable to investigate in such detail as is at present possible the relations between Recent Man, Verneau's Grimaldi Negroid Type and the Cromagnon Type as far as the femur is concerned. The accompanying table places in parallel columns the characters of the Cromagnon Type, of Recent Man as represented by our 17th century London bones, the Grimaldi Negroid Type and the Modern Negro. The reader must not for a moment be over impressed by the apparent weightiness of the numerical data here assembled. The columns of Recent Man are alone based on unity of method, adequacy of material and

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[1] Bibl. 102 *bis*, and Bibl. 102 *ter*.

[2] There are a good many species where the double type occurs, and without taking refuge in achondroplasia and pathological causes, it may be that physiology will ultimately throw light on the not uncommon appearance of the double type.

TABLE I. *Measurements of the Femora of Primogenial Man and Comparatives.*

Character		Apes								*Pithecanthropus erectus*	Primogenial Man									Modern Man 17th century Londoners	
		Gorilla		Chimpanzee		Orang-utan		Gibbon			Type A				Type B		Type C₁	Type C₂			
											Neanderthal	Spy	*Homo Mousteriensis* (*Hauseri*)	La Chapelle aux Saintes	Cromagnon	Tilbury	Galley Hill	*Homo* ~~*Aurigiensis*~~ (*Hauseri*)			
	Number Sex	authors' 5 3♂+2♀	others + authors'	authors' 1♂	others + authors'	authors' 1♂	others + authors'	authors' 1?	others + authors'	L. 1 (from photographs and Dubois)	L. 1 (from cast)	R. 1 (from cast)	L. 1 (from cast)	R. 1 (from photographs)	1 (from cast)	1 (from cast)	L. 1 (from cast)	R. + L., 2 (Klaatsch and photographs)		283 to 487 ♂ (R. + L.)	197 to 381 ♀ (R. + L.)
Major Lengths	Maximum Length	344·6	354·2 (21)	314	293·4 (11)	243	265·2 (5)	203·8	—	455	446·5	429·5	384	430·5	—	—	424·0	425		447·24	409·19
	Trochanteric Length	346·4	—	310	—	225	—	202·2	—	437	426	417	372?	411	—	—	—	410		425·81	389·10
	Maximum Troch. Length	348·4	—	313	—	233	—	203·2	—	450	435	425	373·5?	417	—	—	—	416		434·60	397·77
	Oblique Length	344·6	362·0 (20)	311	289·9 (13)	241·5	265·3 (7)	203·7	204·6 (3)	452	444	428·5	377?	429	[464]	[400]	423·1	423		444·92	405·82
	Trochanteric Oblique Length	346·4	360·7 (7)	312	302·0 (3)	225·2	241·4 (3)	202·1	—	432	426	415	372?	409·5	—	—	—	406·6		423·50	385·71
	Capito-trochlear Length	331·6	—	304·5	—	236	—	199·5	—	441	425	399	356·0	402·6	—	—	408·2	408·0		432·27	394·01
	Diaphysial Length	287·8?	—	260	—	187·5	—	177·9	—	394	380	356	315·0	366	396??	345??	[c. 370]	[c. 374]		~~[383]~~	~~[351]~~
	Length of Shaft	290·8	—	257·5	—	201	—	184	—	395	386	364	324·3	369	—	—	362·2	368		377·09	347·74
Bust	Vertical Diameter of Head	46·3	47·9 (7)	35·9	34·6 (3)	29·3	34·4 (3)	15·9	17·6 (3)	45·0	54·0	55·8	47·7	51·6	—	—	49·2	41		46·91	40·94
	Horizontal Diameter of Head	46·3	—	35·9	—	29·2	—	15·9	—	44·0	52·8	55·0	47·4	50·4	—	—	—	43		46·49	40·60
	Min. Horiz. Diameter of Neck	25·8	—	17·4	—	14·0	—	8·2	—	?	28·1	32·4	32·5	33·0	—	—	24·6?	23		25·68	22·61
	Min. Vertical Diameter of Neck	32·7	—	22·8	—	17·8	—	11·1	—	28·0?	38·2	39·5?	33·2	—	—	—	35·3	31		34·04	29·45
	Capito-collar Length	80·3	—	63·0	—	45·5	—	29·5	—	74·0	64·5	76·2	67·0	82·5	—	—	72·2	69·0		77·12	67·89
	Length of Neck	56·8	—	45·1	—	30·9	—	21·6	—	51·5	37·5	48·3	43·2	56·7	—	—	47·6	48·5		53·67	47·42
Shaft	Proximal Breadth	93·0	—	70·0	—	56·5	—	30·5	—	92·0	104·7	112·0?	92·4	99	—	—	[100·1??]	86		—	—
	Platymeric A.P. Diameter	28·8	29·6 (7)	21·6	20·6 (3)	15·2	17·1 (3)	9·5	10·8 (3)	31·2?	26·5	26·9	23·7	28·6	33·2	26·2	23·8	25·5		26·74	23·58
	Platymeric Trans. Diameter	34·6	35·6 (7)	26·0	27·0 (3)	20·5	22·8 (3)	10·9	12·3 (3)	33·2	36·2	36·2	30·5	33·6	39·2	32·2	35·7	29·5		31·60	28·63
	Pilastric A.P. Diameter	28·0	28·9 (7)	21·2	21·1 (3)	15·4	17·3 (3)	9·6	10·7 (3)	30·0	31·5	32·3	25·0	33·0 (31)*	42·2	35·0	26·2	28·5		29·11	25·61
	Pilastric Trans. Diameter	34·4	36·0 (7)	26·2	26·7 (3)	19·2	22·1 (3)	9·2	11·2 (3)	27·6	30·8	30·0	23·9	28·0 (29)*	33·7	28·0	26·4	25·0		27·99	25·28
	Popliteal Length	140·1	—	127	—	86·7	—	91·1	—	150·0	110·0	110·0	128·5	108??	—	—	147·5	—		121·74	111·13
	Popliteal Width	48·2	50·6 (7)	34·5	30·2 (3)	26·6	27·5 (3)	11·9	12·8 (3)	36·0	40·6	42·9	41·5	36·0?	41·5?	34·5?	44·8	[34·4]		39·65	35·90
	Popliteal Direct A.P. Diameter	25·7	26·6 (7)	23·2	21·7 (3)	16·3	18·1 (3)	8·9	10·5 (3)	32·0	33·1	35·5	29·0	30·0?	37·5?	30·0?	31·0	—		27·97	24·33
	Popliteal Oblique A.P. Diameter	32·5	33·6 (7)	24·2	21·4 (3)	18·1	19·4 (3)	8·9	10·8 (3)	—	28·5	33·9	26·5	—	39·0?	30·5?	29·7	—		30·70	26·82
	Diaphysial Chord	189·4	—	179·6	—	139·0	—	136·0	—	277·0?	253·0	237·4	203·0	236	274·5	257·3	261·9	—		252·70	227·37
	Diaphysial Subtense	5·52	—	4·8	—	3·7	—	0·7	—	7·8?	10·6	9·8	7·8	6·1	11·2	11·4	7·0	—		6·49	5·73
	Proximal Segment of Diaphysial Chord	95·0	—	73·2	—	69·2	—	85·2	—	134·8?	147·3	116·1	110·1	124	113·9	114·9	175·8	—		95·68	93·70
Condyles	Bicondylar Width	84·1	88·9 (7)	69·5	65·2 (3)	52·1	58·0 (3)	25·5	30·0 (3)	78·0	89·6	93·6	83·3?	84·0?	—	—	[88·0??]	75		79·76	70·00
	Max. Length, External Condyle	51·3	—	42·5	—	35·2	—	18·3	—	62·2	75·2	73·7	70·4	[70·7]†	—	—	>64·0	—		62·44	56·12
	Max. Length, Internal Condyle	62·9	—	50·3	—	41·4	—	19·9	—	64·0	69·5	69·1	60·0	64·0?	—	—	—	—		62·06	55·56
	Oblique Length, External Condyle	50·4	—	40·0	—	34·3	—	17·8	—	62·0?	74·2	72·2	68·0	—	—	—	>60·9	—		61·45	55·48
	External Condyle, Hor. Band-Radius	22·1	—	20·1	—	20·0	—	9·0	—	20·0?	25·2?	28·0?	—	—	—	—	—	—		18·90	16·81
	External Condyle, Vert. Band-Radius	21·6	—	19·1	—	12·0	—	8·6	—	22·4?	24·8?	27·7?	—	—	—	—	—	—		20·82	18·48
Angles	Midtrochlear Angle	13°·1	—	9°·0	—	8°·0	—	7°·5	—	8°	7°·5	10°·0	10°·0	11°·0	—	—	8°·0	[8°·5]		7°·85	7°·73
	Angle at Centre of Head	53°·5	—	37°·0	—	38°·0	—	55°·5	—	48°	49°·0	58°·0	57°·5	57°·0	—	—	46°·0	[51°·5]		41°·56	42°·72
	Collar Angle	113°·4	119°·8 (62)	134°·0	127°·1 (35)	134°·0	137°·2 (10)	117°·0	123°·9 (24)	124°·0	123°·5	112°·0	112°·5	112°·0	—	—	126°·0	[120°]		130°·94	129°·85
	Torsion of Shaft	8°·2	—	12°·0	—	5°·0	—	7°·5	—	—	22°·0	38°·0	10°·0	—	—	—	25°·0	—		24°·20	25°·55
	Torsional Angle	3°·6	7°·3 (46)	−3°·5	5°·0 (25)	−7°·0	−4°·4 (6)	9°·0	8°·4 (24)	15°·0	6°·0	16°·0	8°·5	—	—	—	15°·0	—		13°·21	16°·13
	Retorsional Angle	4°·6	—	15°·5	—	12°·0	—	−1°·5	—	—	16°·0	22°·0	1°·5	—	—	—	10°·0	—		11°·24	9°·28
	Obliquity of Shaft	2°·4	—	−2°·0	—	7°·0	—	4°·0	—	12°	5°·5	7°·0	1°·0	3°·0	—	—	8°·5	7°·9		10°·19	10°·61
	Pseudo-Obliquity	0°·0	0°·0 (20)	7°·9	8°·9 (11)	6°·4	0°·0 (5)	0°·0	—	6°·6	6°·1	3°·9	10°·9?	4°·8	—	—	3°·7	5°·6		5°·81	7°·42
General Indices	Oblique-Direct Lengths Index	100·0	100·0 (21)	99·0	98·8 (11)	99·4	100·0 (5)	100·0	—	99·3	99·4	99·8	98·2	99·7	—	—	99·8	99·5		99·36	99·25
	Oblique-Direct Troch. Lengths Index	100·0	—	100·6	—	100·1	—	100·0	—	98·9	100·0	99·5	100·0?	99·6	—	—	—	99·2		99·49	99·36
	Proximal Breadth Ratio	26·8	—	22·6	—	25·1	—	15·1	—	21·1	24·6	26·9?	24·8?	24·1	—	—	[24·6?]	21·0		—	—
	Distal Breadth Ratio	24·3	24·6 (7)	22·4	—	23·2	—	12·6	—	17·8	21·0	22·4	22·4?	20·4	—	—	[21·6??]	18·3		18·77	18·13
	Robusticity of Femur	18·2	18·2 (46)	15·2	16·1 (25)	14·3	15·5 (6)	9·2	10·8 (24)	12·7	14·0	14·0	14·5?	14·8	[16·4]	[15·8]	12·4	12·6		12·84	12·57
Bust Indices	Robusticity of Head	26·8	25·6 (48)	23·1	22·6 (27)	24·2	26·4 (8)	15·6	16·8 (24)	19·7	24·1	25·9	25·2	24·8	—	—	23·3	19·9		21·02	20·17
	Ellipticity of Head	100·0	—	100·0	99·9 (25)	99·7	99·5 (6)	100·0	—	97·8	97·8	98·6	99·4	97·8	—	—	—	104·9		98·86	99·10
	Ellipticity of Neck	78·9	75·5 (21)	76·3	75·5 (11)	78·7	76·2 (5)	73·9	—	?	73·6	82·0?	97·9	—	—	—	69·6?	74·2		75·69	76·92
	Secondary Index of Neck	55·5	—	48·5	—	47·9	—	51·6	—	?	53·2	58·9	68·6	—	—	—	50·0?	53·5		55·23	55·54
	Head-Bust Ratio	56·40	—	57·0	—	64·4	—	53·9	—	60·8	83·7	73·2	71·2	62·5	—	—	68·3	59·4		61·32	60·70
	Primary Bust Ratio	23·9	—	20·1	—	18·7	—	14·5	—	16·3	14·5	17·7	17·4	19·2	—	—	17·0	16·2		17·24	16·66
	Secondary Bust Ratio	23·9	22·9 (46)	20·3	18·9 (25)	18·8	20·7 (6)	14·5	13·6 (24)	16·4	14·8	17·9	17·9	19·2	—	—	17·5	16·3		17·35	16·78
	Bust-Shaft Index	28·3	—	24·5	—	22·6	—	16·0	—	18·7	16·7	20·9	20·7	22·4	—	—	19·9	18·8		20·48	19·62
	Capital Ratio	13·4	13·5 (7)	11·4	11·8 (3)	12·1	12·8 (5)	7·8	—	9·89	12·1	13·0	12·4	12·0	—	—	11·6	9·6		10·49	10·03
	Capito-bicondylar Index	55·1	53·9 (7)	51·7	53·1 (3)	56·2	59·3 (3)	62·4	58·7 (3)	57·7	60·3	59·6	57·3	61·4?	—	—	[55·9??]	54·7		59·02	58·22
	Epiphysial Ratio	98·1	—	90·6	—	87·3	—	115·7	—	94·9	72·0	81·4	80·4	98·2?	—	—	[82·0??]	92·0		96·88	96·22
Shaft Indices	Platymeric Index	83·9	81·4 (48)	83·1	82·1 (27)	64·1	71·4 (8)	87·2	83·4 (26)	94·0?	73·2	74·3	77·7	85·1	84·7	81·4	66·7	86·4		85·22	82·87
	Pilastric Index	85·2	77·1 (68)	80·9	84·3 (39)	80·2	80·0 (17)	104·3	95·0 (30)	108·7	102·3	107·7	104·6	117·9 (106·9)*	125·2	125·0	99·2	114·0		104·43	101·61
	Popliteal Index	53·4	55·4 (11)	67·2	69·4 (5)	61·3	62·6 (8)	74·8	82·1 (7)	88·9	81·5	82·8	69·9	83·3?	90·4?	87·0?	69·2	—		70·84	67·92
	Index of Popliteal Skewness	79·1	~~80·8 (3)~~	95·9	101·7 (3)	90·1	93·4 (3)	100·0	97·2 (3)	—	116·1	104·7	109·4	—	96·2?	98·4?	105·1	—		90·96	90·57
	Popliteal Pyramidal Index	34·3	—	27·2	—	30·7	—	13·1	—	24·0	36·9	39·0	32·3	33·3?	—	—	30·4	—		33·05	32·83
	Soffit Index	57·2	56·7 (7)	49·6	44·4 (3)	51·1	47·6 (3)	46·7	42·8 (3)	46·2	45·3	45·8	49·8?	42·9?	—	—	[50·9??]	45·3		49·99	50·86
	Index of Gracility (Upper)	99·0	100·6 (7)	100·7	98·9 (3)	93·7	96·5 (3)	84·4	91·0 (3)	83·1	85·1	82·9	78·4	83·3	86·0	87·0	73·9	84·7		88·83	88·61
	Index of Gracility (Lower)	70·8	73·2 (10)	75·9	77·9 (3)	72·2	73·7 (3)	77·3	84·8 (6)	76·7	75·9	69·9	57·6	77·8	81·2?	81·2?	58·9	72·7		71·04	70·75
	Index of Transverse Slenderness	11·71	—	10·2	—	9·6	—	5·0	—	6·99	7·98	8·24	7·37	7·60	—	—	7·29	6·79		7·431	7·277
	Index of Sagittal Slenderness	9·85	—	8·2	—	7·7	—	5·2	—	7·59	8·16	8·87	7·71	8·94	—	—	7·29	7·74		7·714	7·356
	Index of Proximal Taper	100·5	100·8 (7)	101·9	98·7 (3)	98·7	98·8 (3)	99·0	100·9 (3)	104·0?	84·1	83·3	94·8	86·6	78·7	74·9	90·8	89·5		91·92	92·12
	Index of Distal Taper	89·6	91·6 (9)	109·4	100·0 (7)	105·8	100·7 (9)	92·7	96·9 (7)	106·7?	105·1	109·9	116·0	90·9	88·9?	85·7?	118·3	—		95·97	95·98
	Popliteal-Shaft Index	48·1	—	49·3	—	43·1	—	49·5	—	38·0	28·5	30·2	39·6	29·3??	—	—	40·7	—		32·28	31·99
	Primary Index of Bowing	2·91	—	2·67	—	2·66	—	0·51	—	2·82	4·19	4·14	3·84	2·58	4·08	4·43	2·67	—		2·55	2·50
	Secondary Index of Bowing	50·2	—	40·8	—	49·8	—	62·6	—	48·7	58·2	48·9	54·2	52·5	41·5	44·7	67·1	—		36·85	41·13
Condylar Indices	Condylar Index	61·1	—	61·2	—	67·6	—	71·8	—	79·7	83·9	78·7	84·5?	[84·2]†	—	—	—	—		78·08	79·91
	Condylar Lengths Index	81·7	83·7 (7)	84·5	79·7 (3)	85·0	81·0 (5)	92·0	90·9 (4)	97·2	108·2	106·7	117·3?	[110·5]†	—	—	—	—		100·34	100·80
	Band-radial Index	97·7	—	95·0	92·5 (2)	60·0	79·9 (5)	95·6	91·3 (2)	112·0??	98·4??	98·9??	—	—	—	—	—	—		111·94	110·78
	Bicondylar Ratio	24·4	24·7 (7)	22·1	21·3 (3)	21·4	22·1 (3)	12·5	14·7 (3)	17·4	20·1	21·8	21·7?	19·5	—	—	[20·8??]	17·6		17·83	17·25
	Condylar Troch. Index	14·8	—	12·9	—	15·2	—	8·8	—	~~17·8~~	~~21·0~~	~~22·4~~	~~22·4?~~	[17·2]†	—	—	—	—		14·67	14·48

* Values given by Boule. † Reconstructed.

ERRATA

In column 2 *for* 80·8 (3) *read* 80·8 (7)
,, 9 ,, 17·8 ,, 14·2
,, 10 ,, 21·0 ,, 17·7
,, 11 ,, 22·4 ,, 17·7
,, 12 ,, 22·4? ,, 18·9?
,, 18 ,, [383] ,, 378·1
,, 19 ,, [351] ,, 347·0
,, 17 ,, Homo Aurigiensis *read* Homo Aurignacensis

sameness of sample. In the case of the other races none of these *desiderata* are forthcoming. For the Cromagnon Type we have based our characters on the Cromagnon and Tilbury casts and on the six femora discussed by Verneau. The measurements he gives are few in number and we have had to obtain the bulk of those now provided from the illustrations he gives of two of them[1]. It will therefore be seen that our mean values for the Cromagnon Type are drawn from any number up to eight. Thus very frequently there will be considerable divergence between the mean index and the index of the means. As Verneau provides only the anterior and posterior aspects of his selected femora, we have been unable to determine antero-posterior dimensions (except where he states them) on any femora beyond the original Cromagnon and the Tilbury femora. Verneau's six femora are given as male and that seems highly probable. We consider the original Cromagnon as certainly male and the Tilbury as doubtful. We have assumed it male for the purpose of averaging. This leaves us without a single representative of the Cromagnon woman. This is a great disadvantage as the Grimaldi Negroid Type is represented only by an "Old Woman" and an "Adolescent." We have therefore been compelled to reconstruct a Cromagnon female femur for the purposes of comparison. For the absolute measurements we have used sex factors; for the indices we have used a mixed method giving consideration to all sorts of hints, which depend upon the individual measurements concerned and the experience of the sexual relationships gained from our tables of special characters[2]. Notwithstanding these difficulties we think that this reconstruction of the Cromagnon woman is a moderately satisfactory one. While we have only worked with a maximum of eight and often with only two femora Rodriguez[3] appears to have used 13 for the characters tabled by him.

The following summary indicates our agreements and our divergences (he gives all as males):

	Rodriguez (13)	Pearson and Bell (2 to 8)
Oblique Length	499	519
Robusticity of Femur ...	12·3	13·0
Robusticity of Head ...	21·8	21·5
Pilastric Index	111·6	125·1
Platymeric Index	72·2	73·0
Ellipticity of Head	100·0	99·3
Secondary Bust Ratio ...	17·0	16·4
Collar Angle	126°·0	126°·0

On the whole there is not more disagreement than might be anticipated in two samples of such different sizes. The chief differences are in the absolute lengths. Ours are the bigger and more massive specimens, and this will possibly account for all but the Pilastric Index divergence. Unfortunately Verneau does not provide the pilastric dimensions of any of his femora and we have only been able to obtain the transverse diameters on those he has photographed. For the Grimaldi Negroid Type we depend entirely on Verneau's few measurements and on his plates[1]. A serious difficulty in the case of the modern Negro arises from the fact that no adequate study has hitherto been made of his femur. Further the "Modern Negro" is no more than the "Modern White" a single race. There are as many distinct races of Negroes as of Whites and the simple labelling of skeletons as "Negro" is much to be reprehended. We have been compelled, however, to maintain this general term as our material has had to be collected from many sources. All we can say is that we have given due consideration to each character[2] and it is the best reconstruction of the "Modern Negro" we have been able to provide from the data available. It is admittedly of a temporary character, but will, perhaps, suffice to bring out the points we desire to emphasise.

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[1] The process of measuring illustrations is always risky and arduous. The stated scale (*e.g.* $\frac{1}{2}$ or $\frac{1}{3}$ natural length) is in our experience never accurate and reducing factors have to be determined to make the illustrations accord with the published measurements. Further it is rarely that the femur has been fairly adjusted before photography to the standard planes, and allowance has frequently to be made for this.

[2] We could not deduce all the indices from the absolute measurements, because even in the male case the means are not always deduced from the same individuals.

[3] Bibl. 101, p. 11.

A word may be said here about the measurement of the distal articulation. It will be remembered that this character is given by Parsons for his Rothwell English and by Tamagnini and de Campos for their Portuguese femora instead of the Bicondylar Width. Its ratio to the maximum length we term the Distal Articulation Ratio. The following results show that it is nearly constant for recent Europeans *if measured in the same manner*:

	Rothwell English	Portuguese
♂	16·74	16·77
♀	16·13	16·13

Accordingly there would appear little doubt that for our 17th century Londoners if the Distal Articulation had been measured in Parsons' manner we ought to have found:

♂ 74·9 ♀ 66·0

From these we should have obtained a "Distal Articulation Index" = 100 Distal Articulation/Bicondylar Width, for our material represented by

♂ 93·9 ♀ 94·3

or the Distal Articulation might be found from the Bicondylar Width by multiplying by the factor ·94 *in the case of mean values.*

Actually we did not obtain these values but the following:

		♂	♀
Distal Articulation Breadth	...	70·22	62·25
Distal Articulation Ratio	...	15·76	15·29
Distal Articulation Index	...	89·57	88·53

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[1] Rodriguez also gives four characters for the *Fossile Race Négroïde de Grimaldi*, for which he gives the number of femora as *three*. His measurements are for *female* only: Oblique Length, 434; Robusticity of Head, 20·1; Platymeric Index, 81·8; Index of Head, 102·8. These appear to agree closely with the measurements of the "Old Woman"—*i.e.* would be for a *single* femur. If he actually handled three femora, it is surprising that he has not given us other measurements.

[2] Where the indices provided are the same for ♂ and ♀ it is because our sources provided no sex distinction. The numbers used for each character run from 8 to 100, and are therefore of very different weight.

Now we did not take the distal articulation in Parsons' manner, for it appeared to us very unsatisfactory especially in the case of the Lemuroids and Apes. We took as will be explained later in this Chapter the maximum breadth of the distal articulation. That this should give a result 3 to 4 mm. *less* than that obtained above is to us inexplicable, unless the agreement between Rothwell English and Portuguese for the Distal Articulation Ratio be merely fortuitous.

Unfortunately we do not know how Verneau has measured his distal articulation breadths. Assuming his method to have been like that of Parsons' we must place for comparison in the accompanying table not our actual measurements but those deduced by supposing the Rothwell English Distal Articulation Ratio to apply to all Europeans. Such are the values given in the accompanying table, under 17th century Londoners, but their enclosure in square brackets signifies that they depend on a special hypothesis.

(*b*) *Cromagnon and Recent Man.* We shall now proceed to a comparison of the four types displayed in the table. Let us examine first the Cromagnon Type and that of Recent Man. The Cromagnon Type as compared with the Greater Anthropoids or with the Neanderthal Type shows great increase of size, exaggerated pilaster, exaggerated torsion and exaggerated bowing. Most of these characters were probably advantages from the standpoint of survival, as emphasising uprightness of position and rapidity of movement, but to judge by Recent Man they were over accentuated. The great size was reduced, but Recent Man remained sensibly taller than the Anthropoids or Neanderthal Man. Now let us consider what this reduction in size means. Cromagnon Man is about 20 per cent. larger in femur than Recent Man as represented by our Londoners. The factors by which we must multiply our London male to obtain our Cromagnon male are: Maximum Length, 1·200; Trochanteric Length, 1·203; Proximal Breadth, 1·209; Shaft Length, 1·215. Now suppose we reduced the Cromagnon Type femur in this manner, how would it compare with that of Recent Man? In the first place we should have over-reduced the V. Diameter of Head (1·164), the Length of Neck (1·065), the Capito-collar or Bust Length (1·113), the Bicondylar Width (1·162) and the Distal Articulation (1·121), the reducing factors of which are given in the brackets. In other words the gain in size of the epiphyses was to a very considerable extent maintained. It may be asked why, if the epiphyses maintain so much of the Cromagnon size, this is not shown in the Proximal Breadth? This very heterogeneous measurement is influenced not only by the breadth of the great trochanter, but still more by the size of the Collar Angle, and this has had a very sensible increment and therefore provides *ipso facto* a lessening of the Proximal Breadth.

Now let us look at the cross-dimensions of the shaft. The Platymeric Antero-posterior Diameter (1·074) remains much larger; the Pilastric Antero-posterior (1·326) and Popliteal Antero-posterior (1·311) Diameters have decreased relatively. The Platymeric Transverse Diameter (1·250) has somewhat decreased, but the Pilastric Transverse (1·071) and the Popliteal Width (1·149) have remained larger. These facts are exactly mirrored in the corresponding indices, the Pilastric Index and the Popliteal Index have markedly decreased while the Platymeric Index has increased. In other words Recent Man has lost something of the exaggerated pilastry and

TABLE II. *Cromagnon and Verneau's "Grimaldi Negroid" Types compared with Recent White and Negro Races.*

Character	Cromagnon Type		Recent Man 17th century Londoners		"Grimaldi Negroid" Type		Modern Negro	
Sex: Age:	♂ Adult	Probable ♀ Adult	♂ Adult	♀ Adult	♀ Old	♂ Adolescent	♂ Adult	♀ Adult
Maximum Length	528·3 (5)	483·4	447·2	409·2	436	421	[451·7]	[415·7]
Trochanteric Length	511 (2)	467	425·8	389·1	426	392	—	—
Maximum Trochanteric Length	523 (2)	479	434·6	397·8	430	399	—	—
Oblique Length	518·8 (5)	473	444·9	405·8	434	419	449·4	412·4
Trochanteric Oblique Length ...	504 (2)	459	423·5	385·7	423	391	—	—
Capito-trochlear Length ...	512·5 (2)	467	432·3	394·0	425	410	—	—
Length of Shaft	458·1 (2)	422	377·1	347·7	380	360	—	—
Vert. Diam. of Head	54·6 (5)	47·6	46·9	40·9	43	43	44·3	40·7
Hor. Diam. of Head	52·2 (5)	45·6	46·5	40·6	44	42	44·2	40·6
Min. Vert. Diam. of Neck ...	35·5 (2)	30·8	34·0	29·5	29·5	28·1	—	—
Capito-collar Length	85·8 (2)	75·6	77·1	67·9	79·0	69·3	71·7	66·0
Length of Neck	57·2 (2)	50·5	53·7	47·4	57·5	47·8	49·7	45·7
Proximal Breadth	110 (2)	100	[91·0]	[83·1]	96·1	87·4	[92·8?]	[85·3?]
Platymeric A. P. Diam. ...	28·7 (8)	25·3	26·7	23·6	27	22	24·6	21·2
Platymeric Trans. Diam. ...	39·5 (8)	35·7	31·6	28·6	33	29	31·3	27·7
Pilastric A. P. Diam.	38·6 (2)	33·9	29·1	25·6	—	—	30·9	25·1
Pilastric Trans. Diam.	30·0 (4)	27·1	28·0	25·3	27·0	20·8	26·7	22·8
Popliteal Width	45·6 (8)	41·2	39·7	35·9	39	45	35·7	33·2
Popliteal Direct A. P. Diam. ...	36·7 (8)	31·9	28·0	24·3	33	28	30·3	24·6
Diaphysial Chord	265·9 (2)	239·3	252·7	227·4	—	—	—	—
Diaphysial Subtense	11·3 (2)	10·0	6·49	5·73	—	—	—	—
Prox. Seg. Diaphysial Chord ...	114·4 (2)	112·0	95·7	93·7	—	—	—	—
Bicondylar Width	92·7 (6)	81·3	79·8	70·0	81	74	80·3	72·0
Midtrochlear Angle	6°·7 (2)	6°·5	7°·9	7°·7	11°·0	8°·0	—	—
Angle at Centre of Head ...	47°·3 (2)	48°·5	41°·6	42°·7	50°·5	42°·5	—	—
Collar Angle	126°·0 (2)	125°·0	130°·9	129°·9	118°·5	129°·5	127°·1	[126°·1]
Torsion of Femur	35°·0*	35°·0	13°·2	16°·1	—	—	17°·1	17°·1
Obliquity of Shaft	12°·5 (2) {9°·5 †}	12°·9 {9°·9}	10°·2	10°·6	6°	10°	—	—
Pseudo-obliquity	6°·0	8°·5	5°·8	7°·4	5°·5	5°·5	—	—

Oblique Direct Lengths Index ...	99·2 (2)	99·1	99·4	99·3	99·5	99·5	—	—
Oblique Troch. Lengths Index ...	98·6 (2)	98·5	99·5	99·4	99·4	99·6	—	—
Proximal Breadth Ratio ...	21·6 (2)	21·6	[21·4]	[21·4]	22·6	22·3	—	—
Distal Breadth Ratio	19·0 (2)	18·3	18·8	18·1	19·0	18·9	17·4	[17·0]
Robusticity of Femur	13·0 (2)	12·8	12·8	12·6	[14·4??]	[13·1??]	11·8	11·6
Robusticity of Head	21·5 (3)	20·7	21·0	20·2	20·3	21·3	19·7	19·7
Ellipticity of Head	99·3 (5)	99·5	98·9	99·1	102·3	97·7	99·8	99·8
Head Bust Ratio	62·3 (2)	61·7	61·3	60·7	54·4	62·0	61·6	61·6
Primary Bust Ratio	16·2 (2)	15·7	17·2	16·7	18·1	16·5	[15·9]	[15·9]
Secondary Bust Ratio	16·4 (2)	15·8	17·4	16·8	18·2	16·5	16·0	16·0
Bust Shaft Index	18·7 (2)	17·8	20·5	19·6	16·5	19·2	—	—
Capital Ratio	10·2 (2)	9·9	10·5	10·0	9·9	10·2	9·9	9·8
Capito-bicondylar Index ...	57·6 (2)	56·8	59·0	58·2	53·1	58·1	57·1	55·7
Epiphysial Ratio	92·3 (2)	91·6	96·9	96·2	97·5	93·6	90·7	90·7
Lemotic Index	11·1 (2)	10·7	12·6	11·7	13·2	11·4	11·1	11·1
Platymeric Index	73·0 (8)	70·9	85·2	82·9	81·8	75·9	83·5	83·5
Pilastric Index	125·1 (2)	123·4	104·4	101·6	—	—	109·9	109·9
Popliteal Index	81·0 (8)	77·7	70·8	67·9	84·6	62·2	81·8	81·8
Soffit Index	51·5 (4)	50·7	50·0	50·8	48·1	60·8	45·7	45·7
Index of Gracility (Upper) ...	79·3 (4)	79·0	88·8	88·6	81·8	71·7	84·8	84·8
Index of Gracility (Lower) ...	72·0 (4)	71·8	71·0	70·8	69·2	46·2	72·8	72·8
Index of Trans. Slenderness ...	6·4 (2)	6·3	7·43	7·28	7·1	5·8	—	—
Index of Sagittal Slenderness ...	[8·4 (2)]	8·0	7·71	7·36	—	—	—	—
Index of Proximal Taper ...	76·8 (2)	74·6	91·9	92·1	—	—	79·6	84·5
Index of Distal Taper	87·3? (2)	90·7	96·0	96·0	—	—	98·1	98·0
Primary Index of Bowing ...	4·26 (2)	4·18	2·55	2·50	—	—	—	—
Secondary Index of Bowing ...	43·1 (2)	46·8	36·9	41·1	—	—	—	—
Bicondylar Ratio	18·4 (3)	18·0	17·8	17·3	18·6	17·6	16·9	16·7
Distal Articulation	84·0 (1)	75·0	[74·9]	[66·0]	74	67	[75·7]	[67·1]
Distal Articulation Ratio ...	16·0 (1)	15·5	[16·7]	[16·1]	17·0	15·9	—	—
Distal Articulation Index ...	93·3 (1)	93·7	[93·9]	[94·3]	91·4	90·5	[94·2]	[93·1]

* Value given by Rodriguez. He states (Bibl. 101, p. 11) that he had 13 Cromagnon femora, but he does not give the numbers available for each individual character. The value for the Modern Negro is also based on his data. In modern civilised races the torsion appears to be higher in the female than in the male, but we cannot be sure that this is so in primitive races or prehistoric or fossil man. Manouvrier (Bibl. 71 *bis*) gives for Neolithic Man, ♂ 29°·0 (23), ♀ 27°·3 (10). In the same paper he also gives for Negroes the torsional angle 20°·7 (13). We have thought it best to repeat the male value for the female in the case of the Cromagnon woman and the negress.

† Value given by Verneau; our value is from his illustrations.

exaggerated platymery of the Cromagnon Type, and he has become relatively more concave in the popliteal area[1]. The remaining indices of the shaft show the same effect of these main shaft changes. The Soffit Index has not changed much for both Popliteal Width and Bicondylar Width have lagged in the general reduction of size; this applies also to the Distal Articulation Index. The Index of Gracility (Upper) has much increased because of the lag in the Pilastric Transverse and the accelerated decrease in the Platymeric Transverse. There is not much change in the gracility of the lower part of the shaft because Pilastric Transverse and Popliteal Transverse have both lagged. The Index of Proximal Taper has much increased because the Platymeric Antero-posterior has lagged and the Pilastric Antero-posterior has been accelerated in decrease. The Index of Distal Taper has also increased although not to the same extent as both Pilastric and Popliteal Antero-posterior Diameters have lagged but not to the same extent. To sum up Recent Man has acquired more rotiform Platymeric and Pilastric Sections and a less rotiform Popliteal Section than Cromagnon Man. In Pilastric Section he has reverted somewhat to the Neanderthal Type and in Platymeric and Popliteal Sections to the Greater Anthropoids.

If we turn to the main femoral angles, we note that the exaggerated torsional angle (35°) has been at least halved presenting thus a partial return to the lower torsion of the Anthropoids and Neanderthalloids. The Collar Angle—which is low in Neanderthal Man, increases in Cromagnon Man and reaches a value in Recent Man as high as, if not higher than, in the Anthropoids—again appears as a return since Neanderthalloid times to a more pithecoid character[2]. Bowing also which is so exaggerated in the Cromagnon and some of the Neanderthal femora has reverted in Recent Man to something like the value of the Greater Anthropoids.

As compared with Neanderthal Man, Cromagnon Man shows in his femur many of the characteristics of Recent Man. He made a really enormous stride in the development of the pilaster, the marked torsion, the bowing, the concave popliteal area, the rotiform character of the platymeric section and the great increase of length and therefore of stature. It is exactly as if he had provided the essentially human characteristics of the femur in an exaggerated form and evolution had then to retrace partially, but far from wholly, its steps. If we assume Anthropoids or Neanderthal Man—still more if we assume the Lemuroids—in the direct line of human descent we should at least have to introduce a link like Cromagnon—it may be in a less exaggerated form—before we could account for the femoral characters of Recent Man. It is for further study to determine whether the link was a modified Cromagnon, from which was side tracked our known Cromagnon, or as a more violent mutation was

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[1] The Anthropoids, Neanderthal Man and Galley Hill Man are convex in the popliteal area, Cromagnon Man is slightly concave or flat, Recent Man has on the average slight convexity. These points are well illustrated in the diagrams of the popliteal sections, which certainly seem to suggest a continuous evolution in this character: see our pp. 486–487.

[2] If our value for the obliquity of the Cromagnon Type be correct or at least more comparable with the values we ourselves have found for other races, there is the same increase of obliquity in the Cromagnon Type compared with the Neanderthal Type and the same partial regression to an earlier value in Recent Man.

Cromagnon itself followed by a regression in some of the over exaggerated human features of that type.

(*c*) *Verneau's Grimaldi Type.* We now ask ourselves where Verneau's fossil negroid Grimaldi Type stands with regard to Cromagnon and Recent Man. Unfortunately we here suffer from possessing only a senile and an adolescent specimen, and for these having no torsion, no bowing and no Pilastric Antero-posterior Diameter. According to Humphry[1] the Collar Angle does not decrease with old age, and this view is also held by Charpy[2]. If this be correct the low Collar Angle of the Negroid Old Woman is noteworthy. We believe, however, that it is either senile or pathological. The appearance of the femur in the plates suggests something anomalous in the neck. Its low value, however, hinders, even if it were truly characteristic, any criterion of relationship to the other races in the table being based on it. In young children the Collar Angle is higher than in the adult, but an "Adolescent" is hardly a child, and we should not be justified in reducing the Collar Angle of the "Adolescent" by more than a degree or two at most if even this were legitimate. On the other hand we might anticipate that the distal epiphysis of the Adolescent would not be proportionately developed and accordingly not much trust must be placed in indices involving the Bicondylar Width or Distal Articulation for the Adolescent.

Now let us look at the *differentia* between the Modern Negro and Recent White Man as represented by our 17th century Londoners. The Negro has a somewhat longer femur, but no stress can be laid on this, for the femur of the Rothwell English would have been larger than these Negro femora. It is important, however, that the White Man with a small femur has a larger head (in the case of the male) and a longer neck, so that the bust is greater. There is little to choose between the two in Proximal or Distal Breadths, the Negro femur being slightly larger; the same remark applies to Distal Articulation. In the Platymeric dimensions the White is slightly the larger. The Pilastric Transverse and the Popliteal Width are somewhat greater in the White. The Collar Angle in the Negro is less than in the English, but it has a value frequently given for the French; the Torsion is probably somewhat higher in the Negro. But taken all round we may safely say that there are no *absolute* measurements, nor indeed any combination of absolute measurements, that would enable us to assert with a high degree of probability that a femur was negroid. The matter is somewhat different when we come to the *relative* proportions or indices. The Platymeric Index offers little criterion, but the Pilastric and Popliteal Indices of the Negro are markedly higher; the Soffit Index, the Index of Gracility (Upper) and the Index of Proximal Taper are markedly less. There is little difference to be noted in the Index of Gracility (Lower) or the Distal Articulation Index. The following indices are greater in the White than in the Negro although to a less marked degree than those just mentioned: the Distal Breadth Ratio and the Bicondylar Ratio—the White has relatively somewhat larger epiphyses; the Capital Ratio, the Capito-bicondylar Ratio, the Bust Ratios—the Bust is relatively greater in the White; the Lemotic Index—the neck is relatively greater in the White; the Robusticity of Femur and of Head. Lastly we draw attention to the Epiphysial Ratio which is markedly greater in the White. The following are therefore the six primary criteria: the Pilastric, Popliteal, Soffit Indices, the Indices of Gracility (Upper) and of Proximal Taper, and the Epiphysial Ratio. There are eight secondary criteria, namely: the Distal Breadth, the Bicondylar, the Capital, the Capito-bicondylar and the Bust Ratios, the Robusticities and the Lemotic Index. To these fourteen indices we must turn, giving greater weight to the first six, if we wish to test the negroid character of a femur. Now the "Adolescent" femur has the Index of Gracility (Lower) of a child between 12 and 15 years of age (see our p. 305), and therefore had at least five or six years of growth before it. Now in these years we find 42 mm. growth in the Diaphysial Length of the English ♂ femur, that is to say about 12 per cent. increase[1]. But a few rough observations show that the epiphysial part of the length of the femur is about one-seventh at the age of 14 or 15 years, and that the growth of the epiphyses is about double that of the shaft, let us say in round numbers about 25 per cent. Thus six-sevenths of the "Adolescent's" femur grow at 12 per cent. and one-seventh grows at 25 per cent., or we have a growth factor of say 1·14. The adult maximum ♂ length would be 480. To confirm this value we may take the "Old Woman's" femur, and allowing 4 mm. for senile shrinkage[2], we have a maximum length of 440 for the female, giving a sex ratio of 1·091. The sex ratio of our 17th century Londoners' femora is 1·093; the sex ratio in *stature* of British Round Barrow is 1·090, of Ancient Anglo-Saxons 1·096, of Swiss Alemanns 1·091—thus the value found is not excessive especially in the case of tall primitive races. We have thus two distinct processes open to us to ascertain the adult male Grimaldi Type, *i.e.* (i) to allow say 1 per cent. senile shrinkage to the "Old Woman" and use the sex ratio of the 17th century Londoners, or (ii) to use the above growth rates. Let us test the two methods on fundamental characters. (*a*) *Vertical Diameter of Head*: Sex Ratio gives 50, and Growth Rate 54, we take it at 52. (*b*) *Proximal Breadth*: Sex Ratio gives 106 and Growth Rate 109, we may take it at 107. (*c*) *Bicondylar Width*: Sex Ratio gives 93·5, Growth Rate 92·5, we may take it at 93. (*d*) *Minimum Vertical Diameter of Neck*: Growth Rate 35, Sex Ratio 34. (*e*) *Oblique Length*: Sex Ratio 480, Growth Rate 478, say 478. (*f*) *Capito-trochlear Length*: Sex Ratio 466, Growth Rate 467. (*g*) *Shaft Length*: Sex Ratio 413, Growth Rate 410, say 411. These results are in quite good accordance. The trochanteric lengths are far less satisfactory because we have so little information about the growth of the great trochanter; between 14 and adult age its growth must be very large, far exceeding the growth of the epiphyses. We can only in our ignorance base these values on an average trochanteric sex ratio of 1·096. The sex ratios for the antero-posterior and transverse dimensions of the shaft are more varied; the transverse for the platymeric, pilastric and popliteal sections is very close in all cases tested to 1·106; the antero-posterior is about 1·134 for platymeric and pilastric sections, but as high as 1·152 for the popliteal. We will take 1·143 to represent the sex ratio for antero-posterior measurements of the shaft.

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[1] Bibl. 45.

[2] Bibl. 36.

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[1] *Modern* English adult femur has for the male a diaphysial length of about 390, and for 14 years 348.

[2] The state of the neck suggests that 1 per cent. shrinkage is rather under than over the mark.

When we turn to the growth changes in the shaft between 14 years and the adult, the changes are very complicated. It is not only that the size but the shape of the shaft sections alter. The platymeric section loses much of its platymery, *i.e.* the antero-posterior grows at a greater rate than the transverse diameter; the rates of growth being approximately 1·4 and 1·2 respectively. The popliteal section loses its elliptical and tends to a more circular form. We believe the popliteal width to remain nearly constant while the popliteal antero-posterior diameter grows with a rate of growth of about 1·2. That is to say an adolescent is more apelike in popliteal section and more Neanderthalloid in platymeric section, or more "orangoid" in both than an adult. Our numbers are only the roughest, based, indeed, on the slenderest of data, but we think they express the main lines of change, and on the basis of them we have made our appreciations of the absolute shaft dimensions of the Grimaldi Type male. With the indices greater freedom of judgment must be allowed, for our sex rates and still more our growth rates are only round figures and small changes in value very sensibly affect these indices. We have therefore found the indices from the reconstructed absolute values for the adult male, and then compared these indices with those of the "Old Woman" and of the "Adolescent," giving weight in the latter to the possible growth changes and in the former to what we have learnt of sex differences in the femoral indices in the course of this work. Thus a variety of considerations have been called into play, and we can only say we have done our best possible to create not the "Adolescent" as an individual adult, but the adult male Grimaldi Type as far as can be deduced from the very slender material at our disposal. These values are given in Table III of this chapter and should be compared with the indicial values of the "Old Woman" and the "Adolescent" as given in the second table.

If we ask what are the main features of the Grimaldi Negroid Type thus reconstructed, we must answer (i) a very considerable reduction in size of shaft from the Cromagnon Type but the shaft still remains much above the average of Recent Man, and (ii) only a small reduction in the massive character of the epiphyses which are but slightly less than those of the Cromagnon Type.

In the following table we extract some of the data for the fundamental dimensions in order that the trees may not hinder the reader from seeing the wood.

These figures are of course only roundly approximate, but they do suffice to prove that the problem of whether Verneau's Grimaldi race is nearer to the white or to the negro is non-existent as far as the size of the femur is concerned. The race must have been very much bigger than the average type of Recent Man, whether white or black[1]. *In absolute size it lies between Cromagnon and Recent Man, and is much*

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[1] Bavarians or Rothwell English would have given a result for whites rather in excess of the available sample of negroes. A tall race of negroes might again invert the order as to size. What is obvious is that our 17th century Londoners and the Modern Negroes represent Recent Man, and the Grimaldi Negroid Type differs widely from them with close links to Cromagnon.

SUBTABLE V. *Comparison in Fundamental Lengths, etc. of Cromagnon, Grimaldi and Recent Man.*

Character	Cromagnon ♂	Negroid Grimaldi		Recent White		Modern Negro	
		♂	♀	♂	♀	♂	♀
Maximum Length ...	528	480	440	447	409	452	416
Trochanteric Length ...	511	467	430	426	389	—	—
Shaft Length	458	411	383	377	348	—	—
Proximal Breadth ...	110	107	97	91	83	93	85
Vert. Diam. of Head ...	55	52	43	47	41	44	41
Length of Neck	57	60	58	54	47	50	46
Bicondylar Width ...	93	93	82	80	70	80	72
Distal Articulation ...	84	84	75	75	66	76	67
Collar Angle	126°	128°	?	131°	130°	127°	126°
Torsion	35°	—	—	13°	16°	17°	17°
Bowing	4·3	—	—	2·6	2·5	—	—

nearer to the former in massiveness of epiphyses. It may be looked upon as a link between the two in which some of the exaggerated size of the Cromagnon shaft has been already lost, but the exaggerated massiveness of the epiphyses not yet substantially reduced.

We can now turn from absolute size to the indices and ask if this more precarious material provides any clear evidence of the negroid character of Verneau's Grimaldi femora.

Primary Criteria.

(i) *Pilastric Index.* We have not the pilastric antero-posterior diameter and our direct inquiry has failed to procure it.

(ii) *Popliteal Index.* Old Woman 84·6, Adolescent 62·2, Reconstructed Adult Male 80·0. Probably close to Cromagnon value. Apparently near to Modern Negro also, but we believe the high value of the Modern Negro is due to Hepburn's determination of the popliteal diameters differing from ours: see our p. 124. Under the circumstances this criterion is of no value; all we can say is that the Grimaldi Type is like the Cromagnon, which in this respect *may* be nearer Modern Negro than Recent White, but Hepburn gives 78 for Modern British, a value 7 points in excess of our 17th century Londoners. Thus by our method his Negroes might be 75—a value as remote from the Grimaldi as from the Cromagnon.

(iii) *Soffit Index.* Old Woman 48·1, Reconstructed Adult Male 48·4. These values are intermediate between Cromagnon and Recent White and are not at all modern negroid.

(iv) *Index of Gracility (Upper).* Old Woman 81·8, Reconstructed Adult Male 82·3. Intermediate between Cromagnon and Recent White, but near the former. They are nearer to the Modern Negro than Recent White, because the Modern Negro is about half way from Cromagnon to Recent White.

(v) *Index of Proximal Taper.* Unascertainable.

(vi) *Epiphysial Ratio.* Old Woman 97·5, Reconstructed Adult Male 94·5. Values very divergent from the Negro and in their mean intermediate between Cromagnon and Modern White, but nearer the latter.

Thus of our six primary criteria two fail to be of service; in one case the Grimaldi femora are nearer to the Modern Negro than to the Recent White, but in this case they are close to the Cromagnon value, which diverges considerably from that of Modern Negro. In the remaining cases the criteria are markedly in favour of the Grimaldi Type being an intermediate between Cromagnon and Recent White, and in these cases the Modern Negro lies *outside* the Cromagnon to Recent White range.

Secondary Criteria.

(i) *Distal Breadth Ratio.* ♂ 19·9, ♀ 19·0. Grimaldi Type close to Cromagnon and far nearer to Recent White than to Modern Negro.

(ii) *Bicondylar Ratio.* ♂ 19·0, ♀ 18·6. Fairly close to Cromagnon and remote from Modern Negro.

(iii) *Capital Ratio.* ♂ 10·2, ♀ 9·9. Identical with Cromagnon and nearer to Recent White than to Modern Negro.

(iv) *Capito-Bicondylar Ratio.* ♂ 56·0, ♀ 53·1. Nearer to Modern Negro than to Recent White but not far from Cromagnon.

(v) *Bust Ratio.* ♂ 17·7, ♀ 18·2. High values but both nearer to Recent White than to Modern Negro. The divergence from Cromagnon is due to the retention of the long bust with the reduced shaft.

(vi) *Robusticity of Femur.* Unascertainable as a result of our ignorance of the pilastric antero-posterior diameter.

(vii) *Robusticity of Head.* ♂ 23·4, ♀ 20·3. The mean is practically identical with that of Cromagnon and not far removed from Recent White; divergent from that of Modern Negro.

(viii) *Lemotic Index.* ♂ 12·6, ♀ 13·2. Male as that of Recent White, female in excess of Recent White. Values much nearer those of Recent White than of Modern Negro or Cromagnon.

Summing up our views as based on the above evidence we should say that we have not succeeded in finding any specific modern negroid features in the Grimaldi fossil femora. These femora appear to us to have characters which place them in indices as in absolute size on the whole intermediately between the Cromagnon Type and Recent Man, and their features are in a number of cases closer to the former than the latter. The crania may give more marked negroid characteristics, and we may be dealing with a branch point, where the negro left the ancestral line, but on the basis of the femur alone we consider that Verneau's Grimaldi Negroid Type suggests strongly an intermediate link to Recent Man. It retains several of the Cromagnon features which Recent Man has retained, and it has begun the reversionary process which wiped out some of the exaggerated features of the Cromagnon Type. We look forward with the greatest interest to the possible discovery of an adult male of the Grimaldi Type. That type will have enhanced value, if we regard it not as a migratory variant, but as a stage in the Cromagnon to Recent Man direct line. Our view is, of course, not a dogma but a suggestion, but it is a suggestion which appears to us supported by the osteometric data we have just discussed[1].

(*d*) *Position of Neolithic Man.* If the Grimaldi Type may be taken as an intermediate between the Cromagnon Type and Recent Man[1], although in several features closer to the former, have we any clue to another intermediate which is closer to Recent Man? We think it is distinctly suggested in the characters we know of Neolithic European Man. In Neolithic Man the size of the femur is already that of Recent Man in both diaphysis and epiphyses, but there is still exaggerated torsion, pilaster and platymery. We may take as a compact group Manouvrier's measurements on 23 ♂ Neolithics from Châlons-sur-Marne[2].

SUBTABLE VI. *Comparison of Cromagnon, Neolithic, and Recent Man.*

Character	Cromagnon Man	Neolithic Man	Recent Man
Maximum Length	528	444 (—)	447
Oblique Length	519	441 (444)	445
Vertical Diameter of Head	54·6	46·5 (46·0)	46·9
Platymeric Index	73·0	76·1 (75·1)	85·2
Pilastric Index	125	108 (111)	104
Collar Angle	126°	128° (128°)	131°
Obliquity	12°·5	10°·2 (—)	10°·2
Torsion	35°	29° (19°)	13°

The numbers in brackets under Neolithic Man are those given by Rodriguez for larger but far less homogeneous material. It appears to us that with Neolithic Man the fitting size of the femur had been in broad lines determined, but the sections of the shaft and the torsion remained to be still further modified.

(*e*) *Femur of the "Fringe" Races.* If, as we suggest, the Grimaldi Type and Neolithic Man are not branch lines, but direct links in the chain from Cromagnon Man to Recent Man, and if the series in time order be really a series in evolutionary order, we have still to consider whence the Cromagnon Type itself has sprung. With that type appeared, as we have noted, several of the most characteristic features of the femur of Recent Man, albeit in an exaggerated form. A careful study of the data provided in Table III[3] will suffice to show the reader that the exaggerated Cromagnon features have been preserved to a more marked extent in Neolithic than in Recent Man, but have been retained in a remarkable manner in certain of the fringe races. Thus the Guanches had much of the platymery (76·1), a good deal of the pilastry (111), the low collar angle (124°) and several other features of the Cromagnon Type. Extremely low platymery (68·6 and 63·1) combined with pilastry of the neolithic order is found in Fuegians and Moriori (Scott: Maori ♂ 123·4, Moriori ♂ 117·4) femora. The Polynesian is in these features more closely related than the Australian to the Maori. Indeed the Australian femur is in many respects remarkable; its platymery is that of a modern European, its pilastry and size are suggestive of Cromagnon; but its low Soffit Index and its low Collar Angle (44·9 and 119°) carry us back to Neanderthalloid Man (45·8 and 115°), from which however it differs widely by its reduced robusticities. It is a relatively slender femur with a small head, and except in a few isolated characters it seems to us an error to directly associate it with that of Neanderthal Man. The most we can say of Recent Man is: that isolated features of Primogenial Man whether of the Neanderthal or the Cromagnon Type are still to be found in the fringe races—that the transition from Cromagnon to Recent Man is far easier than the transition from Neanderthal Man to Recent Man would be without a Cromagnon-like link as we should have then to invent such a link to supply the characteristic Cromagnon features.

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[1] Perhaps some further evidence may be deduced from the shape of the patellar surface. In the Cromagnon Type there is not the asymmetrical laterally peaked form typical of Recent Man. It is more like the Neanderthal type of patellar surface, which is distinctly more apelike than that of Recent Man. In the Grimaldi Type, to judge merely from the uncertain photographs, the patellar surface is markedly peaked on the lateral side—there is a distinct departure from Cromagnon towards Recent Man.

[2] Bibl. 71 *bis*, p. 162.

[3] The reader must be careful to neither over- nor under-estimate the value of Table III. We know only too well the shortness of our ape series; we have already endeavoured to impress the reader with the difficulties that have arisen in the case of the femora of Primogenial Man—the diversity and paucity of measurements that have been published and the impossibility of ourselves verifying them in the present state of affairs. We must again emphasise the struggle we have had to obtain anything like consistent results in patching together the meagre data that exist for our representative races of man. It would be idle to give a long string of cases—one will suffice, for it is typical of a whole series of instances. Flower deals with the osteology of the Andamans and gives one measurement only of the femur, presumably its

At the same time if the reader will carefully study the *proportioning* of the femur of Recent Man as given in our columns of mean values of indices in selected groups of Recent Man, he will note (i) that the indices of the shaft are surprisingly close to those of Neanderthal Man, on the whole far closer than to those of Cromagnon Man, (ii) that on the other hand the indices of the epiphyses are, where comparison is

maximum length in the case of the 29 skeletons he had available: ♂ 393·4, ♀ 380·4. These values are clearly incompatible with the oblique lengths as obtained from other writers. To introduce them would be to make an impossible Andamanese femur. We have had to discard them entirely—not because they are essentially erroneous, but because Flower went no further than merely measuring *one* character, and gave us no means therefore of bringing his results into line with those of other investigators. Numerous other rejections have had to be made in like manner. Where we have endeavoured to build up a racial femur from contributions from different sources we have exercised the best discretion we could. But it must be distinctly understood that our table is rather a scheme for future filling in than an accurate representation of the femoral characters in the five main divisions of Recent Man. Only in the columns of our 17th century Londoners is the material homogeneous in source and methods of measurement. Elsewhere we have combined material, used reducing factors, and selected what data it was possible to include. Doubtful measurements or measurements obtained by doubtful reconstructions are enclosed in square brackets. The reader will find that in some cases indices are the ratio of the mean characters provided; in others the indices were given by one writer and the absolute values are deduced from a different series of femora by other writers. We have selected, where available in adequate numbers, the indices as found by one writer from his own material. But this is not always possible; a French writer may give the Capito-collar Length, but take no measurements on the Distal Epiphysis; an English or German writer may give the Bicondylar Width; thus for even a rough appreciation all we can do is to combine mean values obtained on different series for the Epiphysial Ratio. All we claim for our table is that it represents in a rough approximate way the femur of Recent Man in its chief groups—paying special attention to the "fringe" races. Further our last two columns, while not wholly self-consistent, not really characteristic of any one race or one individual, give the characteristic features of the femur of recent *Hominidae* as distinguished from the like features in general of *Simiadae* or *Lemuroidea*. It may be said that this is a small matter, but it appears to us capable of throwing some light on the path of man's ascent.

possible, apparently closer to those of Cromagnon Man than to those of Neanderthal Man. Thus just as if Cromagnon be not an ascendant we should have to insert something like Cromagnon to give the characteristic femoral features of Recent Man, so without Neanderthal we should need to insert something like Neanderthal Man to provide those divergences in the shaft indices from Cromagnon which we have referred to in Recent Man[1]. We can either insert such branch-points in our evolutionary ancestry,—links which will then still remain to be discovered,—or we can take a great forward leap of the femur in Cromagnon Man with a regression since in the direction of an earlier Neanderthal Type; and with this regression in a certain limited sense the human femur has become more apelike. The Cromagnon femur has few apelike characters, but its exaggerated human features were in some manner incompatible with success and the femur of Recent Man stands in several respects between the Cromagnon and Neanderthal Types. The Cromagnon branch-point—if it be a branch-point at all—stands nearer to Recent Man than the Neanderthal branch-point, for it provided features that are strictly recent human and which we scarcely find at all anterior to it.

(*f*) *Position of Galley Hill Femur.* Suppose either case—and one or other seems to us a necessity—Cromagnon and Neanderthal ancestors, or Cromagnon and Neanderthal branch-points with femora like these types in possibly less exaggerated forms, then the main difficulty seems to us to lie not in the accepting of such a line of descent, but in finding links between these two types or at least between the branch-points corresponding to them in the direct human line of ancestry. Thus far—and there are difficulties to be cleared up—we have only come across the Galley Hill femur as anything like an intermediate, but it does provide certain good sequences in the more important characters—if others, possibly owing to the difficulty of reconstruction, raise considerable doubts. In the first place the Galley Hill femur shows at least the beginnings of a pilaster, which practically fails in the Neanderthal Type; its popliteal section is by no means a bad intermediate between those of *Homo mousteriensis* (*Hauseri*) and of the Cromagnon R. (see Diagrams, p. 486) and it has a large assortment of the "anomalies" of Recent Man, which are almost specific characters of the Neanderthal Type (see our p. 456 ftn.). In the second place the Galley Hill femur as it stands is in many measurements already an intermediate; it is an intermediate in a good many more —if, as we suspect, it is a *female*. Thus we should have approximately the system on the following page, taking the Fuegians sex-ratios, as the most fitting for the case.

Now this table indicates the great divergence of the Galley Hill femur from that of Recent Man. The basis of resemblance is just in those characters where Recent Man has reverted from the Cromagnon towards the Neanderthal Type. The examination of the indices of the shaft is less satisfactory—in large measure we believe owing to the bad condition of the Galley Hill bone. But even here an examination of Table III will show that these indices do not strengthen the relation of Galley Hill

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[1] The marked bowing, the pilaster and the torsion, the Cromagnon features of Recent Man, also concern the shaft. Notwithstanding it is not incorrect to assert that the *proportioning* of the shaft in Recent Man is more Neanderthalloid than Cromagnon-like in character.

SUBTABLE VII. *Comparison of Neanderthal, Galley Hill, Cromagnon and Recent Man for male Femora.*

Character	Neanderthal	Galley Hill	Cromagnon	Recent Man
Maximum Length	423	456 (424)	528	441
Oblique Length	420	455 (423)	523	436
Vert. Diam. of Head	52·3	52·9 (49·2)	54·6	45·1
Vert. Diam. of Neck	37·0	40·7 (35·3)	35·5	33·6
Capito-collar Length	75·0	77·6 (72·2)	85·8	72·5
Length of Neck	46·4	51·2 (47·6)	57·2	50·0
Proximal Breadth	102	108? (100·1?)	110	88·8
Popliteal Width	40·3	48·2 (44·8)	45·6	36·0
Bicondylar Width	87·6	94·6? (88·0?)	92·7	78·7
Torsional Angle	10°·2	15°·0	35°·0	19°·5
Collar Angle	115°·0	126°·0	126°·0	127°·4
Obliquity	4°·1	8°·5	12°·5	9°·8
Proximal Breadth Ratio ...	25·1	(24·6?)	21·6	21·3
Distal Breadth Ratio	21·6	(21·6??)	19·0	18·7
Robusticity of Femur	14·3	12·6* (12·4)	13·0	12·4
Robusticity of Head	25·0	23·3	21·5	20·6
Head Bust Ratio	72·7	68·3	62·3	62·3
Primary Bust Ratio	17·2	17·0	16·2	16·6
Bust Shaft Index	20·2	19·9	18·7	20·5
Capital Ratio	12·4	11·6	10·2	10·5
Epiphysial Ratio	83·0	(82·0?)	92·3	94·5
Bicondylar Ratio	20·8	20·7?	18·4	17·9

* For reasons previously given we think the Pilastric Tranverse is under-estimated.

to Recent Man; if they could be trusted, which we doubt, they would suggest that in some respects Galley Hill was more pithecoid than the Neanderthal Type. The conclusion that suggests itself to our minds is that Galley Hill is a most valuable link, either directly between the Neanderthal and Cromagnon forbears of man or at least between the Neanderthalloid and Cromagnon branch-points in the human pedigree. In this respect it appears to us as one of the most valuable of the "finds."

The time may come when we are able to give our judgment as based on the crania, but on consideration of the femora only we suggest that the Galley Hill Type is a Neanderthal-Cromagnon intermediate and the Grimaldi Negroid Type a Cromagnon-Recent Man intermediate.

(iv) *On the supposed Hylobatic Ancestry of Man.*

(*a*) *Arguments based on the Anomalies.* If this view be approximately correct—*i.e.* that before reaching the femur of the ape-man the human femur must have passed through a massive bowed and pilasterless form, through something approaching the Neanderthalloid femur, if not that femur itself—it seems erroneous (i) to give the femur of the true *Pithecanthropus* the Recent Man form of the Trinil femur, and then (ii) to link this form up with the immediate ancestor of the gibbons with its slender, non-robust, non-bowed, and almost pilasterless femur[1]. The Neanderthal femur suggests that the femur of *Pithecanthropus erectus* when found will have far more kinship with those of the greater anthropoids than with either the Trinil femur or that of the gibbon—although it will undoubtedly be closer to the fossil *Dryopithecus* than to recent *Hylobates.* The common ancestor of the gorilla, the chimpanzee and the orang would possess the needful robusticity, the bowing and the insignificance of the pilaster. We may ask: which of the three greater anthropoids comes nearest to man[1] as far as the femur is concerned? As a step towards throwing light on this problem we shall discuss the anomalies of the femur.

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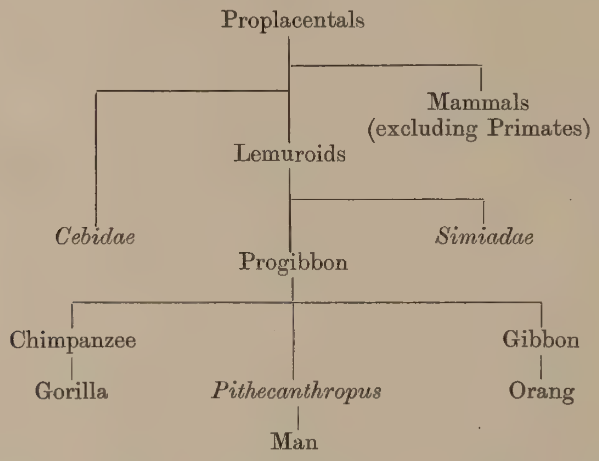
[1] Haeckel in his *Natürliche Schöpfungsgeschichte*, Zweite Ausgabe, 1870, S. 571, links Man more closely to the Gibbon than to the Chimpanzee.

It is well, however, to remind the reader first of the form of pedigree which has been propounded for the primates. Haeckel[2], if we start with the Proplacentals, has the following scheme:



According to this scheme the New World Monkeys diverged, not from the Lemuroids, but from some ancestor of the Lemuroids nearer to the branch-point of the "Mammals" (Primates excepted!); if this view be correct lemuroid characters would be more likely to occur in the *Simiadae* than in the *Cebidae.* Again a Progibbon is made ancestor of the three lines, (i) Gibbon leading to the Orang, (ii) *Pithecanthropus* leading to Man, and (iii) the Chimpanzee leading to the Gorilla. We must suppose the femur of the Progibbon to be not very widely removed from that of *Dryopithecus rhenanus.*

Abel[3] holds that *Dryopithecus* may have been a forerunner of the Orang, but has no genetic relation to *Pithecanthropus erectus*—presumably he considers the Trinil femur belongs to the latter, but he is arguing from the teeth; Schlosser holds *Dryopithecus* not to be a forerunner of man, although he considers that the ancestor of man had a femur not unlike that of *Dryopithecus*. Pohlig takes the order of relationship, Orang, Gorilla, Chimpanzee, *Dryopithecus*, Man; and Gaudry, *Dryopithecus*, Gorilla, Pliopithecus, Gibbon, Orang, Chimpanzee, Man. It is not quite clear what these relational orders signify, but the origin of their differences with regard to *Dryopithecus* seems to be the relative weight which various authorities place (i) on the great divergences in the form of the mandible between Man and *Dryopithecus* and (ii) on the resemblance of the teeth, which in *Dryopithecus* are said to be the most human of all the anthropoids. No direct comparison seems to have been made of the femora.

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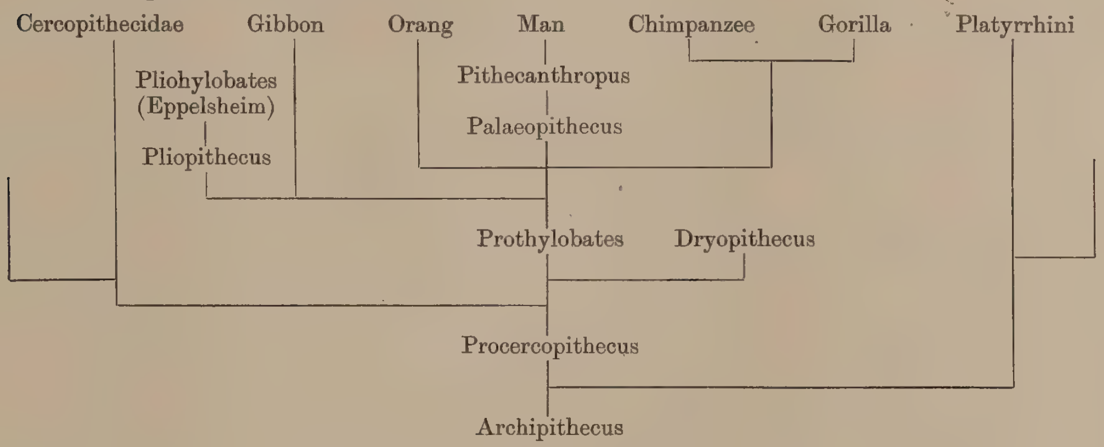
[1] Any descent of man from a type close to that of one of the existing anthropoids is, we believe, to be repudiated, and the principle involved in the statement that man is descended from an ape, only enforces the previous existence of a man-ape from whom Primogenial Man and the anthropoids are alike descended. Indeed it would be just as true—or false—to assert that the gorilla is a degenerate man as to suggest that man is an emended gorilla. The femur—and what is more, the skull—of an infant man bears little resemblance to those of the adult gorilla, but the femur—and above all the skull—of an infant gorilla are far more human in character than their adult forms. Indeed the skull of the infant gorilla is far more human in character than the skull of any *adult* ape whatever. This fact is at any rate a warning that we must not be intensely surprised if the skull of the ape-man—of the common ancestor of man and the anthropoids—were more human and less baboon-like than has been generally supposed. Without being wildly hypothetical one might dream of the real *Pithecanthropus* as a Neanderthalloid dwarf with a cranium approaching that of an infant gorilla!

[2] Ernst Haeckel, *Last Words on Evolution*, 1905, Plate I, English Translation of same year.

[3] Bibl. 87 *ter.*

Dubois gives the scheme[1]:



and Schwalbe[2] gives *Pithecanthropus*, Primogenial Man, Recent Man, both judging, we believe, more by the skull than the femur.

Now it will be seen that most of these orders give either a gibbon-like ancestor to man, or place *Dryopithecus* in relatively close proximity to Man. Now this would not be so hard to accept in the case of the femur, if the ancestral line were: Eppelsheimer femur, Trinil femur, Recent human femur[3]. But we have to bear in mind that both the Cromagnon and Neanderthal Types have to be accounted for, and we may safely assert that from the standpoint of the femur, it is exceedingly difficult to interpose a gibbon-like ancestor between the branch-point of the *Simiadae* and Neanderthal Man!

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[1] Bibl. No. 70 *bis*, S. 21.

[2] Bibl. No. 94 *ter*.

[3] Here also is the difficulty of Schwalbe's order—the Trinil femur is wholly that of Recent Man, how can we interpose the Neanderthal Type or even Cromagnon Type between these two? It seems absolutely needful to separate the Trinil femur from the skull, if we are to accept Schwalbe's order. The same objection applies even more forcibly to Dubois' extended pedigree. He separates, contrary to the views of Abel (Bibl. No. 87 *ter*, S. 1171 *et seq.*), the Eppelsheimer femur from the mandible and other fragments of *Dryopithecus*. We must suppose *Procercopithecus* to have had the considerable bowing and robusticity of the *Cercopithecidae*, that these are lost in *Prothylobates*, are recovered in marked degree at the anthropoid branch-point, are lost again at *Palaeopithecus* or at *Pithecanthropus*, resumed in Neanderthal Man and to some extent lost again in Recent Man. Having made no independent study of the *Dryopithecus* fragments we are perfectly neutral on the question of whether the Eppelsheimer femur is that of a *Dryopithecus*. When we speak of *Dryopithecus* in relation to the femur we always refer to the Eppelsheimer bone, the femur of Abel's *Dryopithecus rhenanus*.

Take, for example, the character of bowing; this is well marked in the *Simiadae*, it is well marked in Neanderthal Man, and it is retained, if in a less emphasised manner, in Recent Man. The gibbon has *negative* bowing and *Dryopithecus* very slight positive bowing. The *Cebidae* show considerable variation in bowing, but possess a sensible positive bowing on the whole. The Lemuroids show slight or negative bowing, and Haeckel's pedigree would compel us to assert that bowing had *twice* appeared and then disappeared in the Primate descent! It is much more probable that *Cebidae* and *Simiadae* both came from a common bowed form, possibly Lemuroid in character or that the Lemuroids lie on a branch line. Again, is it reasonable to insert an unbowed gibbon-like ancestor between the branch-point of the highly bowed *Simiadae*, and the highly bowed Greater Anthropoids and Primogenial Man?

We may take it that the appearance of a rare anomaly in one primate, which is characteristic of another, is a strong indication of the order of descent, or at least of relationship. Lemuroid characters undoubtedly occur in Man, *i.e.* such features as the lateral protrusion of the anterior face, the presence of a third trochanter, and even that frontal ridge which we have ventured to call the "anterior pilaster[1]." Our Plate LXV shows a case of lateral protrusion and anterior pilaster in man, such as occur in the lemurs, and may even be found as far back as the mammals and marsupials[2]. Now, lateral protrusion of the anterior face is almost as rare in the *Simiadae* as in Man, and presumably was so in their branch-point; it is probably a relic of Lemuroid ancestry. Are we to insert a primate (*i.e.* the Gibbon) which has lateral protrusion as a characteristic between the branch-point of the *Simiadae* and those of the Greater Anthropoids and Man?

Again, a considerable number of the *Simiadae* have sensible traces of a pilaster; in some cases the apex of the popliteal surface is appreciable. There are no traces of a pilaster in the Gibbons and but little significant in *Dryopithecus*. In the Lemuroids the popliteal apex cannot be determined, and it cannot be determined in the Gibbons or *Dryopithecus*. Are we to interpolate this pilasterless, apexless form between the branch-point of the *Simiadae* and the immediate ancestor of Man? Even in the anthropoids some rough guess may be made at a popliteal apex, and the posterior face, if lacking the pilaster in the classical sense, far more nearly resembles that of Neanderthal Man than that of the Gibbon. Again, the femoral head in the case of the Gibbon has a relatively large and irregular fovea. This fovea strangely enough is absent in the Orang. It is occasionally absent or practically absent in the case of Man. This point was unfortunately not regarded when the London femora were examined for anomalies. But in re-examining 140 of these femora for another purpose, practical absence—a small, slightly rough patch not hollowed out—was noted in one case[1]. In this respect there is accordingly another link between Man and the Greater Anthropoids which is lacking in the case of the Gibbon. The third trochanter in a marked form is more frequent in Man than in the Gibbon, and this again is an objection to the interpolation of the Gibbon between the Lemuroids and the Ape Man[2].

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[1] An indication of what we mean by a "frontal pilaster" is to be seen in *Dasypus sexcinctus*. Cf. Fig. III of our Plate XXVII, and it may also be traced in the common rabbit, Fig. IV of the same plate.

[2] An illustration (see our p. 342) of a "lemuroid" human femur with lateral protrusion of the anterior face and frontal pilaster is provided by Martin in a photograph of a Fuegian femur (Bibl. No. 111 *bis*, S. 1023). It is not given, however, as illustrating these points. We owe to the great kindness of Professor Martin a cast of this femur. It convinces us that a study of the anomalies of the femora of the Fuegian and other "fringe" races would be of much interest.

We turn now to the *fossa hypotrochanterica*. As far as we are aware it has not hitherto been noted as characteristic of any primate, and it has only been described as an anomaly in the case of Man. In some of the *Simiadae* there is a posterior fossa, but it runs sagittally down the posterior face, and cannot, we believe, be identified with the *fossa hypotrochanterica* in Man. At first sight this anomaly appears to be peculiar to him. Another *fossa* peculiar to a primate, but always occurring, is the *fossa angulolateralis* of the Gorilla. It is asserted that the *fossa angulolateralis* never occurs as an anomaly in Man. We ourselves have never noted in the human femur the lower portion of the spiral of this fossa on the lateral face of the femur, *i.e.* the part which is so characteristic of the gorilla femur. But traces of the *fossa angulolateralis* are to be found in both orang and chimpanzee, and it seems almost possible to insert a series of individual chimpanzee femora bridging the stages from the full *fossa angulolateralis* of the Gorilla to the *fossa hypotrochanterica* of Man. See our Plate LXII. If no vestige of the *fossa hypotrochanterica* is to be found in the Greater Anthropoids, and no vestige of the *fossa angulolateralis* in Man, then the link between the Greater Anthropoids and Man must ante-date the appearance of both these *fossae*. Yet the further we go back in the history of Man, the more marked and frequent becomes the *fossa hypotrochanterica* (see our p. 453). Again, the *fossa angulolateralis* bears the character of a vestige in the Orang, and would appear to be vanishing in the Chimpanzee, if it be not developing into something bearing close resemblance to a hypotrochanteric *fossa*. If the link between the Orang, Man and the Chimpanzee were actually a pro-Gibbon even of the approximate type of *Dryopithecus rhenanus*—having a femur without any sign of either *fossa*—we should have to imagine both *fossae* developing *de novo* in three lines traced from a living form which shows no signs of either. Is it not more reasonable to suppose that the common ancestor of Man possessed a *fossa* somewhat resembling the *hypotrochanterica* of Primogenial Man, which developed through the Chimpanzee forms into the exaggerated *fossa angulolateralis* of the Gorilla, and appears in a weakened form in the Orang, while in Man, from frequent appearance in Primogenial Man, it has become merely an anomaly in Recent Man? If this view be not accepted we have to explain the *rise* as well as the decline of the *fossa angulolateralis* in the Orang, its continuous rise in the Chimpanzee-Gorilla line and the rise and fall of the hypotrochanteric *fossa* in the human line. Occam's razor suggests that it is better to replace the non-fossed pro-gibbon by a fossed individual[1], *i.e.* one having a femur of greater robusticity and muscularity than *Dryopithecus rhenanus.* To obtain such unity of origin a fuller inquiry as to a possible link between the *fossa hypotrochanterica* and the *fossa angulolateralis* would be well worth making.

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[1] In Cunningham's *Anatomy* (Thompson), followed in Quain's *Anatomy* (Bryce), there is a statement that human femora have been recorded without the pit or *fovea capitis*. We have been unable so far to trace the statement to its original source.

[2] Klaatsch (Bibl. 102 *bis*, S. 567) provides an octopodous pedigree of a novel if not easily interpretable kind! It would suggest that Mikronegroids and Australians are closer than any of the Greater Anthropoids to the *Propithecanthropus*. It does not help as the Gibbons are not taken into consideration to throw light on our present problems.

We now turn to the vexed question of the curvature of the popliteal area, or rather of the posterior face, of the standard popliteal section taken parallel to the standard horizontal plane at one-tenth the diaphysial length from patellar articular border. The diagrams on pp. 486—7 illustrate the nature of these sections in Man and the Anthropoids. In the Gorilla we have extreme convexity, somewhat lessened but still marked in the Chimpanzee. The Gibbon has about the same degree as the Chimpanzee, and the section of the Eppelsheimer femur (*Dryopithecus rhenanus*) is very similar to that of the Recent Gibbon (*H. mülleri*), except that the internal supracondylar ridge is more emphasised. A change, however, comes over the posterior face of the section when we turn to the Orang; the curvature is zero or the section may even be very slightly concave. At first sight this may appear to be a special development of the Orang, but we must be cautious in judging this because other characters as well as this (*e.g.* the low great trochanter) are common to Man and the Orang. Turning to the popliteal section of the infant Gorilla, we see that it bears a close resemblance to that of the Orang, the posterior face is flat even to a slight concavity. The popliteal sections of the infant Orang and of the infant Chimpanzee are both very similar to that of the Gorilla, differing only in size, and the suggestion is that the common ancestor of Orang, Man and Chimpanzee had a flat rather than convex popliteal surface. The Chimpanzee-Gorilla line and Man in the Neanderthal Type line developed the convex popliteal surface. Turning to the sections of the human femur, we see that Neanderthal L., Spy R., *Homo mousteriensis* (*Hauseri*) L., Galley Hill L. form an almost continuous series with increasing flatness of the posterior face of the section till we get the transition to perfect flatness or even slight concavity of the Orang type in Tilbury L. and Cromagnon R., and the series culminates in the distinguishable, but not very marked or always present, concavity of the popliteal area of Recent Man (see our pp. 486 and 487).

Another feature which is of interest in this section is the slight concavity of the anterior face on the mesial side; it does not occur in any of the Anthropoids to our knowledge—in the Gorilla the slight flattening is, if anywhere, on the lateral side of the anterior face. But it is present in Neanderthal Man, is traceable in Galley Hill and marked in Tilbury and Cromagnon. We should expect to find it relatively

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[1] It may be noted that in the infant gorilla the femur has the *fossa angulolateralis* in its lower part as a slightly depressed rugous trough, much like the vestigial *fossa* of the adult Orang; the hypotrochanteric portion of it may be more depressed and smoother floored, but is somewhat more to the frontal border of the lateral face than is usual with the *fossa hypotrochanterica* in Man.

Pithecanthropus erectus

Neanderthal Type

Grimaldi Type (2)§

Homo aurignacensis (Hauseri) (2)

Neolithic Europeans

Neolithic Europeans

Berbers and Guanches

Berbers and Guanches

17th century Londoners

17th century Londoners

American Indians

American Indians

Fuegians

Fuegians

Moriori and Maori

TABLE III. *General Summary of Mean Values of Femoral Characters in the Primates.*

		LEMUROIDS AND APES																								
		LEMUROIDEA						CEBIDAE								SIMIADAE					HYLOBATINAE		SIMIINAE			
	Genus or species →	Tarsiidae (2)	Lorisinae (6)	Galaginae (6)	Lemurinae (18)	Indrisinae (8)	Chiromyrdae (2)	Hapalinae (16)	Nyctipithecinae (8)	Brachyurus (2)	Pithecia (2)	Mycetes (2)	Cebus (6)	Lagothrix (2)	Ateles (4)	Macacus (14)	Cynocephalus (8)	Cercocebus (4)	Cercopithecus (8)	Semnopithecus (10)	Gibbon (2)	*Dryopithecus rhenanus*	Gorilla ♂ (4), ♀ (3)		Chimpanzee (2)	Orang (5)
	Characters ↓ Sex ...	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂ or ♀	♂	?	♂	♀	♂ or ♀	♂ or ♀
MAJOR LENGTHS	Maximum Length	64·2	76·75	61·2	129·0	151·7	124·65	65·9	88·8	155·2	129·6	151·65	119·5	112·0	223·5	173·3	228·9	219·95	142·1	200·6	193·55	287·0	368·35	309·0	314·55	236·7
	Trochanteric Length	63·9	75·4	60·8	131·6	154·4	123·75	66·0	87·9	153·9	127·3	148·75	119·2	110·0	218·1	175·6	234·2	222·85	144·0	202·7	192·2	284·2	370·75	304·9	311·0	219·2
	Maximum Troch. Length	64·1	76·1	61·05	132·0	154·0	124·0	66·1	88·1	154·25	128·05	149·5	120·0	109·5	219·5	175·9	234·4	222·6	145·0	202·8	193·1	285·0	373·5	305·8	313·35	224·8
	Oblique Length	64·1	76·5	61·1	128·7	151·2	124·55	65·7	88·4	154·85	129·3	151·55	110·35	111·5	223·3	172·9	228·2	218·4	142·0	199·3	193·5	286·3	367·4	307·2	311·85	235·7
	Trochanteric Oblique Length	63·85	75·2	60·7	131·3	154·1	123·65	65·9	87·6	153·85	126·85	148·7	118·8	109·5	217·95	175·4	234·1	222·2	143·9	202·45	192·15	284·0	370·7	304·5	311·85	218·5
	Capito-trochlear Length	61·75	72·7	58·5	123·6	145·9	118·45	62·9	84·5	150·95	124·9	142·9	113·45	105·4	214·4	165·6	220·2	211·35	135·0	192·2	187·4	279·9	349·95	297·9	303·65	227·8
	Diaphysial Length	55·5	65·7	51·5	110·3	135·95	109·65	57·0	77·8	137·15	115·05	130·65	103·7	94·7	188·2	149·3	199·1	191·6	123·4	174·5	170·7	255·9	309·1	253·0	261·8	182·2
	Length of Shaft	60·0	67·6	55·65	117·6	139·1	113·0	58·9	79·55	139·0	116·75	132·55	104·85	95·95	192·95	153·0	201·8	197·9	127·6	180·1	174·85	252·7	309·8	257·3	257·35	188·7
BUST	Vertical Diameter of Head	3·7	7·2	4·7	10·8	10·6	10·3	5·6	6·9	11·65	9·3	13·5	10·4	11·25	18·7	16·4	21·2	16·9	12·7	17·0	15·0	24·0	50·8	40·4	36·15	30·0
	Horizontal Diameter of Head	4·0	7·0	4·9	10·7	10·65	10·75	5·6	7·0	11·6	9·3	13·4	10·4	11·45	18·7	16·3	20·9	17·0	12·6	16·9	15·1	23·9	50·6	40·7	36·2	29·9
	Min. Horizontal Diameter of Neck	2·15	4·55	3·0	6·2	6·2	6·1	2·9	3·7	5·85	4·45	8·1	5·7	6·75	9·9	10·0	11·2	11·2	7·3	10·6	7·55	14·3	27·85	22·3	17·55	12·9
	Min. Vertical Diameter of Neck	3·7	5·3	4·5	8·2	8·5	7·65	4·4	5·6	8·15	6·35	9·15	7·5	8·25	12·55	12·75	15·1	14·0	10·3	13·4	10·0	16·8	36·45	27·3	22·7	17·8
	Capito-collar Length	4·85	8·5	5·8	15·3	15·6	12·25	7·5	9·4	17·3	14·3	21·65	15·1	17·8	33·5	23·5	32·15	26·2	17·1	23·8	26·05	43·4	84·15	68·4	62·4	48·8
	Length of Neck	3·05	4·9	3·5	9·4	10·3	7·1	4·6	5·9	11·5	9·65	14·9	9·9	11·65	24·2	15·3	21·5	17·75	10·75	15·3	18·5	31·4	58·7	48·2	44·3	33·8
SHAFT	Proximal Breadth	8·55	11·65	10·0	23·5	23·45	21·35	11·4	12·7	22·4	18·9	24·9	20·7	20·1	35·7	33·85	45·7	36·0	26·4	33·2	28·75	50·0	103·3	79·3	68·5	60·3
	Platymeric A.P. Diameter	3·1	4·5	4·0	8·1	7·45	7·05	4·0	4·6	7·7	6·7	8·95	6·9	9·1	14·5	12·3	15·4	13·25	9·2	12·5	9·0	18·4	31·7	25·2	21·95	15·1
	Platymeric Trans. Diameter	3·5	4·9	3·9	8·9	8·65	8·5	4·4	5·55	8·7	7·6	9·65	8·2	9·65	15·8	12·9	16·3	14·3	9·5	12·6	10·75	20·1	37·0	30·2	26·2	20·3
	Pilastric A.P. Diameter	3·45	4·4	4·0	7·8	7·8	7·2	3·9	4·45	7·35	6·55	8·9	6·4	8·35	13·2	12·7	16·0	13·45	9·7	12·1	9·45	17·8	31·5	24·7	21·4	15·8
	Pilastric Trans. Diameter	2·9	4·9	3·65	7·9	7·6	7·4	4·1	4·7	7·1	6·7	9·45	7·0	7·75	13·9	12·3	15·85	13·35	9·7	12·1	8·75	17·5	38·3	30·6	25·85	19·8
	Popliteal Length	?	?	?	?	?	?	?	?	?	?	?	?	?	90·25?	55·1?	96·1?	86·2?	57·9?	83·7?	89·9??	?	150·25?	124·6?	123·15?	91·8?
	Popliteal Width	3·05	6·85	4·5	8·8	8·6	8·85	5·0	6·45	9·45	7·5	11·1	8·8	12·4	18·8	15·3	20·1	15·15	12·0	15·2	11·1	25·2	54·7	42·9	34·35	25·4
	Popliteal Direct A.P. Diameter	3·15	4·1	4·0	7·4	7·1	6·8	3·8	4·5	6·35	5·55	8·25	6·1	8·25	12·55	12·5	15·5	12·85	9·4	11·8	8·65	16·0	27·95	22·0	23·45	16·7
	Popliteal Oblique A.P. Diameter	2·7?	3·7	4·0	7·6	6·9	7·1	3·9	4·9	6·4	5·5	7·45	6·2	8·2?	13·2	13·2	15·5	13·7	9·6	12·7	8·6	18·0	37·0	26·5	25·15	17·2
	Diaphysial Chord	39·6	45·1	36·1	78·1	103·6	73·0	40·2	58·0	105·85	85·05	91·9	75·9	65·2	147·1	106·5	143·7	144·45	89·3	132·55	133·1	187·5	194·1	178·5	179·8	130·9
	Diaphysial Subtense	−0·5	−1·1	−0·6	−0·0	0·6	0·85	0·9	0·5	2·05	1·05	2·75	1·1	1·1	3·3	3·9	5·2	3·8	3·65	3·8	−0·2	1·1	6·8	5·6	5·25	2·4
	Proximal Segment, Diaphysial Chord	11·75	13·9	14·3	35·85	63·6	29·0	20·5	26·5	50·55	34·45	37·95	42·05	31·7	74·3	52·4	68·5	74·2	41·3	58·1	94·25	55·2	92·0	86·9	77·2	59·3
CONDYLES	Bicondylar Width	6·9?	12·0	8·5	17·7	17·5	18·6	10·1	13·0	19·9	16·8	25·7	18·95	22·0	32·9	29·0	36·6	29·5	22·6	29·0	25·25	41·1	92·55	73·8	69·3	50·2
	Max. Length, External Condyle	8·25	8·3	9·2	18·2	19·2	16·5	8·65	11·0	15·6	13·1	18·75	13·6	13·1	24·1	23·7	30·55	26·15	19·5	24·9	18·0	31·0	55·5	45·5	43·4	33·4
	Max. Length, Internal Condyle	8·3	9·5	9·0	17·0	17·25	15·3	8·2	10·9	15·05	12·9	19·4	14·1	13·45	25·25	24·7	31·9	26·4	19·7	24·1	19·15	30·0	68·65	54·7	51·5	41·2
	Oblique Length, External Condyle	7·55	7·85	8·2	16·6	18·0	15·05	7·9	10·3	14·8	12·7	17·75	13·0	12·55	23·6	23·1	30·3	25·0	18·9	23·4	17·45	29·2	54·7	44·8	41·45	33·0
	Oblique Length, Internal Condyle	7·7	8·5	7·75	15·7	16·7	14·75	7·6	10·1	14·35	12·2	17·65	13·05	12·45	23·5	22·9	29·6	24·65	18·7	22·4	17·6	28·6	62·65	50·1	45·45	35·8
	External Condyle, Hor. Band-Radius	2·75	4·1	3·6	6·9	6·45	5·45	3·4	4·0	6·2	5·9	7·4	6·25	5·6	8·9	9·0	11·2	11·85	7·2	10·1	7·45	13·7	24·9	20·7	20·1	15·4
	External Condyle, Vert. Band-Radius	1·95	3·3	2·7	6·8	7·0	4·15	3·1	4·2	6·75	6·0	7·6	6·6	5·9	8·35	8·9	10·4	11·8	6·9	9·8	7·25	13·0	24·5	19·8	19·55	12·7
	Height, Patellar Surface	5·9	5·6	5·6	12·7	10·0	7·95	4·7	5·6	9·75	6·7	9·6	7·2	6·4	11·75	12·1	15·65	15·95	10·6	13·6	10·95	16·8	27·1	21·8	22·6	19·6
	Breadth, Distal Articulation	6·1	9·7	7·7	15·9	16·4	16·0	9·0	11·6	12·15	15·25	22·9	16·85	19·95	30·5	26·2	34·2	26·4	20·4	26·25	22·6	35·3	82·6	67·7	58·3	46·8
ANGLES	Midtrochlear Angle	4°·3	5°·5	5°·3	6°·7	5°·7	5°·5	5°·9	5°·45	5°·0	5°·7	8°·0	6°·4	8°·5	7°·1	7°·2	7°·3	6°·25	6°·6	6°·4	7°·25	7°·0	13°·9	11°·2	9°·0	8°·0
	Angle at Centre of Head	66°·7	51°·8	60°·6	64°·1	62°·1	57°·5	55°·6	54°·6	44°·5	53°·8	57°·0	52°·6	53°·5	47°·0	54°·4	56°·25	56°·25	61°·1	58°·7	58°·25	47°·5	56°·5	48°·3	37°·75	33°·3
	Collar Angle	109°·0	122°·7	114°·1	109°·25	112°·2	117°·0	118°·5	120°·0	130°·5	120°·5	115°·0	121°·0	118°·0	125°·9	118°·4	116°·4	117°·5	112°·3	116°·95	114°·5	125°·5	109°·6	120°·5	133°·25	138°·7
	Torsion of Shaft	− 3°·0	−20°·4	− 0°·5	11°·7	14°·6	7°·5	16°·1	17°·75	17°·5	21°·5	−21°·0	−1°·5	−8°·3	−13°·0	4°·45	9°·1	4°·0	1°·5	1°·85	5°·25	7°·0	11°·25	0°·7	10°·5	5°·8
	Torsional Angle	−10°·2	−18°·7	−10°·6	7°·4	11°·6	−3°·0	8°·2	10°·2	14°·75	11°·0	−12°·7	−5°·3	−9°·7	− 4°·1	9°·4	18°·5	8°·75	15°·05	11°·45	16°·0	13°·5	9°·75	4°·7	3°·75	−5°·65
	Retorsional Angle	7°·2	− 1°·7	10°·1	4°·25	3°·1	10°·5	7°·8	5°·5	2°·75	10°·5	− 8°·3	3°·8	1°·4	− 8°·9	−5°·0	−9°·5	−4°·75	−13°·55	−9°·6	−10°·75	−6°·5	1°·5	−4°·0	6°·75	11°·45
	Obliquity of Shaft	3°·7	5°·5	2°·1	2°·2	1°·2	3°·0	1°·4	−0°·1	1°·5	3°·4	2°·0	3°·9	−2°·2	3°·35	1°·5	−0°·5	0°·85	2°·6	−0°·7	3°·0	4°·0	2°·9	0°·4	−0°·1	5°·2
	Pseudo-Obliquity	2°·25	3°·8	3°·2	2°·9	4°·3	2°·3	2°·5	3°·4	3°·45	3°·9	1°·45	2°·2	5°·4	1°·7	2°·7	2°·4	6°·5	1°·1	4°·7	0°·0	4°·0	2°·0	3°·5	7°·5	4°·85
GENERAL INDICES	Oblique-Direct Lengths Index	99·85	99·7	99·7	99·8	99·7	99·9	99·8	99·6	99·8	99·8	99·95	99·9	99·6	99·9	99·8	99·7	99·3	99·9	99·4	100·0	99·8	99·8	99·4	99·1	99·6
	Oblique-Direct Troch. Lengths Index	99·9	99·75	99·7	99·8	99·9	99·9	99·9	99·8	99·95	99·65	99·95	99·7	99·5	99·95	100·0	99·95	99·7	100·0	99·85	100·0	99·9	100·0	99·9	100·3	99·7
	Proximal Breadth Ratio	13·4	15·2	16·4	17·8	15·45	17·25	17·3	14·2	14·55	14·85	16·75	17·4	18·25	16·0	19·3	19·4	16·15	18·35	16·2	15·0	17·6	27·85	26·0	22·15	27·5
	Distal Breadth Ratio	10·8	15·7	14·4	13·4	11·4	15·0	15·3	14·85	12·9	13·2	17·3	15·9	20·0	15·1	16·45	15·6	13·25	15·7	14·5	13·15	14·5	24·95	24·2	22·25	22·9
	Pithecoid Index	99·6	98·4	99·9	102·0	101·9	99·25	100·1	99·2	99·4	98·1	98·1	99·5	98·25	97·65	101·4	102·5	101·75	101·3	101·2	99·3	99·2	100·85	99·1	100·0	92·7
	Robusticity of Femur	9·9	12·05	12·6	12·1	10·2	11·8	12·1	10·3	9·3	10·25	12·1	11·2	14·4	12·2	14·3	14·0	12·25	13·7	14·9	9·4	12·3	18·9	18·0	15·15	14·9
BUST INDICES	Robusticity of Head	12·0	18·3	15·8	16·5	14·2	16·9	17·0	16·3	15·05	14·4	17·75	17·5	20·35	16·7	18·9	18·5	15·55	17·9	17·1	15·55	16·7	27·6	26·4	23·2	25·4
	Ellipticity of Head	108·1	98·2	103·6	99·2	100·2	104·35	100·1	100·7	99·55	100·0	99·3	100·2	101·8	100·0	99·3	98·9	100·6	99·1	99·35	100·7	99·6	99·55	100·7	100·15	99·5
	Ellipticity of Neck	58·15	90·5	68·2	70·5	72·4	79·75	65·2	65·2	72·5	70·2	88·55	76·75	76·85	78·8	77·9	74·5	80·1	72·0	79·0	75·7	85·1	78·7	81·5	77·3	72·7
	Secondary Index of Neck	53·75	64·6	60·8	58·6	58·1	56·75	51·6	52·0	50·45	47·85	60·45	54·9	58·95	52·9	60·8	54·1	65·9	58·4	62·6	49·95	59·8	55·0	54·6	48·5	43·2
	Lemotic Index	4·75	6·4	6·2	7·25	7·1	5·7	6·6	6·8	7·3	7·95	9·8	8·35	10·9	10·8	8·8	9·35	8·1	7·6	7·4	9·55	10·8	16·0	15·7	14·2	14·4
	Head Bust Ratio	76·35	83·8	78·0	70·4	67·75	84·1	76·7	74·0	67·35	65·25	62·35	69·2	63·7	55·9	70·0	66·8	64·5	75·4	73·5	58·15	55·3	60·8	59·2	57·95	61·6
	Primary Bust Ratio	7·55	11·0	10·05	11·8	10·6	9·8	11·2	10·7	11·15	11·05	14·25	12·7	15·9	15·0	14·3	14·0	11·9	12·1	11·7	13·4	15·1	22·8	22·1	19·85	20·6
	Secondary Bust Ratio	7·55	11·1	10·1	11·8	10·6	9·8	11·2	10·7	11·2	11·05	14·25	12·7	15·95	15·0	14·3	14·0	12·0	12·1	11·8	13·4	15·2	22·85	22·3	20·05	20·7
	Bust Shaft Index	8·05	12·5	11·0	12·9	11·6	10·85	12·5	11·9	12·3	12·25	16·35	14·5	18·6	17·35	15·4	15·8	13·25	13·4	13·05	14·85	17·2	27·15	26·6	24·25	25·9
	Capital Ratio	5·75	9·2	7·8	8·3	7·1	8·3	8·5	7·8	7·55	7·2	8·9	8·7	10·05	8·35	9·5	9·3	7·7	9·0	8·5	7·75	8·4	13·8	13·1	11·5	12·7
	Capito-bicondylar Ratio	53·6	59·5	54·35	60·5	61·0	55·35	55·4	53·2	58·55	55·35	52·55	55·0	51·15	56·9	56·8	58·1	57·25	57·1	58·6	59·4	58·4	55·0	54·8	52·2	60·1
	Epiphysial Ratio	70·25	71·3	70·4	86·4	90·9	65·9	73·4	72·8	86·9	85·05	84·25	80·3	80·85	102·1	81·6	87·3	88·85	76·25	80·5	103·05	105·6	91·0	92·6	90·0	97·6
SHAFT INDICES	Platymeric Index	88·85	91·2	107·5	91·6	87·8	82·95	91·2	85·5	88·5	88·2	92·75	86·8	94·35	94·3	96·4	94·9	92·75	96·65	100·2	83·7	91·5	85·65	83·9	83·8	74·7
	Pilastric Index	115·7	89·5	111·3	99·0	101·7	97·3	95·1	94·9	103·5	97·8	94·25	91·6	107·75	94·8	103·4	101·2	100·7	99·3	99·5	108·15	98·3	81·9	80·8	82·8	82·1
	Popliteal Index	106·6	60·3	87·2	84·2	81·6	76·85	76·1	70·2	67·25	74·1	74·35	69·6	66·55	66·5	82·8	77·0	84·7	79·3	77·3	78·2	63·5	51·1	51·7	68·25	65·9
	Index of Popliteal Skewness	121·15	111·7	101·2	92·2	90·7	95·8	90·9	96·5	99·2	100·9	110·75	99·3	100·6	95·0	101·9	96·5	93·65	99·9	94·8	100·6	88·9	75·5	80·3	93·35	97·7
	Popliteal Pyramidal Index	?	?	?	?	?	?	?	?	?	?	?	?	?	21·1?	27·1?	22·65?	17·65?	20·55?	21·9?	?	?	36·5?	34·3?	27·95?	27·7
	Soffit Index	44·2	57·45	52·8	49·8	49·4	47·6	49·6	49·1	47·45	44·65	43·2	46·3	56·35	57·45	52·3	55·1	51·35	53·25	52·6	43·95	61·3	59·1	58·0	49·55	50·9
	Index of Gracility (Upper)	83·3	99·35	94·85	89·0	89·0	87·1	92·9	84·8	81·6	88·25	98·0	87·4	80·35	90·5	95·7	97·3	93·35	102·4	95·65	81·35	87·1	103·65	101·6	98·7	95·3
	Index of Gracility (Lower)	95·05	71·6	79·4	89·7	88·3	83·6	82·2	73·9	75·2	89·45	85·15	79·6	62·5	74·85	80·7	78·85	88·2	81·65	79·1	78·95	69·4	70·1	71·8	75·25	76·1
	Index of Transverse Slenderness	4·85	7·2	6·55	6·7	5·5	6·5	6·9	5·9	5·1	5·75	7·1	6·6	8·1	7·2	8·0	7·8	6·75	7·6	6·6	5·0	6·9	12·35	11·9	10·05	10·2
	Index of Sagittal Slenderness	5·6	6·4	7·2	6·6	5·6	6·4	6·6	5·6	5·25	5·6	6·7	6·1	8·7	6·8	8·35	7·9	6·8	7·6	6·6	5·4	7·0	10·1	9·6	8·3	8·4
	Index of Proximal Taper	89·9	103·0	102·2	104·4	98·2	96·6	101·3	106·4	104·75	102·25	100·55	108·7	109·05	110·0	97·7	96·5	98·7	94·2	105·7	95·2	103·3	101·3	102·2	102·35	95·6
	Index of Distal Taper	94·2	92·6	98·9	96·2	91·7	94·4	97·7	100·8	86·45	84·75	92·7	95·7	98·8	94·4	99·0	96·9	95·4	97·9	99·8	91·5	89·9	89·4	89·2	109·55	105·7
	Popliteal Shaft Index	?	?	?	?	?	?	?	?	?	?	?	?	?	46·7?	35·8?	44·25?	43·55?	44·95?	39·3?	?	?	48·55?	48·5?	47·85?	48·7
	Primary Index of Bowing	−1·25	−2·4	−1·35	0·0	0·6	1·15	2·4	0·9	1·95	1·25	3·0	1·45	1·7	2·3	3·8	3·7	3·1	4·1	2·8	−0·15	0·6	3·5	3·2	2·95	1·8
	Secondary Index of Bowing	29·7	30·9	44·4	47·8	65·6	39·9	51·3	46·35	47·75	40·55	41·3	49·0	48·65	50·3	49·1	47·7	51·45	46·2	43·0	70·95	29·4	47·6	48·5	42·95	45·2
CONDYLAR INDICES	Condylar Index	119·6?	68·7	104·3	103·0	110·3	88·7	86·1	84·1	78·4	77·95	72·95	71·6	59·55	73·25	81·7	84·8	88·65	87·0	83·6	74·4	75·4	60·0	61·6	62·65	66·7
	Condylar Lengths Index	99·4	86·9	103·5	106·8	111·4	107·9	105·7	101·1	103·65	101·55	96·65	96·6	97·4	95·5	96·0	97·2	99·05	99·2	102·9	94·1	103·3	80·8	83·2	84·2	81·2
	Bicondylar Ratio	10·75	15·4	14·35	13·7	11·6	14·95	15·3	14·7	12·8	12·95	16·9	15·85	19·65	14·8	16·7	15·9	13·45	15·8	14·6	13·05	14·3	25·1	23·9	22·0	21·2
	Band-radial Index	70·9	81·9	75·15	98·4	109·0	77·45	91·6	104·1	108·9	101·7	102·7	105·3	105·4	95·4	97·7	93·8	99·6	96·7	100·6	97·8	94·9	98·8	96·1	97·25	82·7
	Condylar Troch. Index	12·9	10·75	14·9	13·8	12·6	13·35	13·1	12·5	10·15	10·25	12·6	11·4	11·9	11·05	13·5	13·25	11·7	13·6	12·05	9·4	10·9	14·75	14·9	13·95	15·3
	Distal Articulation Ratio	9·5	12·5	12·8	12·3	10·9	12·85	13·7	13·0	11·3	11·75	15·1	14·1	17·8	13·65	15·1	14·9	12·0	14·3	12·9	11·75	12·3	22·4	21·9	18·55	19·8
	Distal Articulation Index	88·45	80·65	90·1	90·0	93·2	86·05	89·0	88·6	87·9	90·75	89·1	89·0	90·7	92·9	90·5	93·2	89·5	90·6	91·0	89·7	85·9	89·1	91·7	84·15	93·3
	Rotular Ratio	9·2	7·2	9·05	9·9	6·8	5·45	7·2	6·3	6·3	5·15	6·25	6·0	5·7	5·75	7·0	6·75	7·25	7·4	6·7	5·7	5·9	7·4	7·1	7·2	8·3
	Rotular Index	96·75	57·2	69·4	80·2	62·3	49·7	53·0	48·9	55·7	43·95	47·45	42·7	32·05	38·5	46·7	45·1	60·4	51·8	51·0	48·3	47·6	32·9	32·4	38·75	42·0
	Diaphysial Rotular Ratio	10·6	8·4	10·8	11·5	7·6	7·3	8·3	7·2	7·1	5·8	7·3	6·9	6·8	6·1	8·1	7·8	8·3	8·45	7·7	6·45	6·6	8·8	8·6	8·6	10·7

			TYPES OF PRIMOGENIAL MAN					RECENT MAN, SELECTED GROUPS AND RACES											
								EUROPEAN WHITES						AMERICAN RACES					
	Genus or species →	*Pithecanthropus erectus*	Neanderthal Type (6)	Galley Hill (1)	Cromagnon Type (5)	Grimaldi Type (2)§	*Homo aurignacensis (Hauseri)* (2)	Neolithic Europeans	Neolithic Europeans	Berbers and Guanches	Berbers and Guanches	17th century Londoners	17th century Londoners	Eskimo	Eskimo	American Indians	American Indians	Fuegians	Fuegians
	Characters ↓ Sex ...	?	♂	♀?	♂	♂	♀?	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
MAJOR LENGTHS	Maximum Length	455·0	423·0	424·0	528·0	480·0	425·0	444·0	410·0	449·9	422·8	447·24	409·19	—	—	421·6	389·9	433·7	403·5
	Trochanteric Length	437·0	406·5	—	511·0	467·0	410·0	—	—	424·2	398·7	425·81	389·10	—	—	397·2	368·1	420·4	390·2
	Maximum Troch. Length	450·0	412·6	—	523·0	471·0	416·0	—	—	—	—	434·60	397·77	—	—	—	—	—	—
	Oblique Length	452·0	419·6	423·0	519·0	478·0	423·0	441·0	406·0	447·2	420·3	444·92	405·82	425·9	410·8	417·1	384·7	432·6	402·4
	Trochanteric Oblique Length	432·0	405·6	—	504·0	464·0	407·0	—	—	—	—	423·50	385·71	—	—	—	—	413·9	383·7
	Capito-trochlear Length	441·0	395·7	408·0	513·0	466·0	408·0	—	—	—	—	432·27	394·01	—	—	—	—	—	—
	Diaphysial Length	394·0	354·0	c. 370·0	—	—	c. 374·0	—	—	—	—	378·14†	347·02†	—	—	—	—	—	—
	Length of Shaft	395·0	361·0	362·0	458·0	411·0	368·0	—	—	—	—	377·09	347·74	—	—	—	—	—	—
BUST	Vertical Diameter of Head	45·0	52·3	49·2	54·6	52·0	41·0	46·5	40·8	45·5	42·7	46·91	40·94	45·8	43·3	43·7	40·4	46·8	43·5
	Horizontal Diameter of Head	44·0	51·4	—	52·2	50·0	43·0	46·1	40·5	45·4	42·0	46·49	40·60	46·0	43·5	43·6	40·3	46·5	43·2
	Min. Horizontal Diameter of Neck	—	31·5	24·6?	—	—	23·0	—	—	—	—	25·68	22·61	—	—	—	—	27·3	24·1
	Min. Vertical Diameter of Neck	28·0?	37·0	35·3	35·5	34·0	31·0	—	—	—	—	34·04	29·45	—	—	—	—	33·2	28·8
	Capito-collar Length	74·0	75·0	72·2	85·8	86·0	69·0	74·4	67·8	73·8	69·3	77·12	67·89	73·6	71·0	70·4	65·2	73·4	68·3
	Length of Neck	51·5	46·4	47·6	57·2	60·0	48·5	51·2	47·4	51·0	47·9	53·67	47·42	50·7	49·4	48·5	44·9	50·5	47·0
SHAFT	Proximal Breadth	92·0	102·0	100·1?	110·0	107·0	86·0	—	—	—	—	94·54†	85·32†	—	—	—	—	89·6	83·3
	Platymeric A.P. Diameter	31·2?	26·4	23·8	28·7	31·0	25·5	[25·3]	[24·0]	—	—	26·74	23·58	[27·5]	[26·0]	—	—	23·2	20·8
	Platymeric Trans. Diameter	33·2	34·1	35·7	39·5	35·0	29·5	[33·2]	[29·5]	—	—	31·60	28·63	[31·0]	[29·5]	—	—	36·2	32·8
	Pilastric A.P. Diameter	30·0	30·5	26·2	38·6	—	28·5	29·2	26·9	29·7	27·9	29·11	25·61	29·0	28·0	27·2	25·1	29·9	27·0
	Pilastric Trans. Diameter	27·6	28·2	26·4	30·0	29·0	25·0	26·8	24·2	26·8	25·2	27·99	25·28	26·5	25·5	25·3	23·4	26·3	24·5
	Popliteal Length	15·0	114·1	147·5	—	—	—	—	—	—	—	121·74	111·13	—	—	—	—	—	—
	Popliteal Width	36·0	40·3	44·8	45·6	45·0	[34·4]	[40·0]	[36·9]	—	—	39·65	35·90	—	—	—	—	—	—
	Popliteal Direct A.P. Diameter	32·0	31·9	31·0	36·7	34·0	—	[28·1]	[25·9]	—	—	27·97	24·33	—	—	—	—	[30·8]	[26·8]
	Popliteal Oblique A.P. Diameter	—	29·6	29·7	—	—	—	—	—	—	—	30·70	26·82	—	—	—	—	—	—
	Diaphysial Chord	277·0??	232·0	261·9	266·0	—	—	—	—	—	—	252·70	227·37	—	—	—	—	—	—
	Diaphysial Subtense	7·8?	8·6	7·0	11·3	—	—	—	—	—	—	6·49	5·73	—	—	—	—	—	—
	Proximal Segment, Diaphysial Chord	134·8?	124·4	175·8	114·4	—	—	—	—	—	—	95·68	93·70	—	—	—	—	—	—
CONDYLES	Bicondylar Width	78·0	87·6	[88·0]?	92·7	93·0	75·0	[79·7]	[73·6]	[82·0]	[72·0]	79·76	70·00	81·5	69·7	—	—	81·5	75·8
	Max. Length, External Condyle	62·2	72·5	[>64·0]	—	—	*	—	—	—	—	62·44	56·12	—	—	—	—	64·7	60·1
	Max. Length, Internal Condyle	64·0	64·7	—	—	—	*	—	—	—	—	62·06	55·56	—	—	—	—	—	—
	Oblique Length, External Condyle	62·0?	71·1	[>60·9]	—	—	—	—	—	—	—	61·45	55·48	—	—	—	—	—	—
	Oblique Length, Internal Condyle	61·0?	66·7	—	—	—	—	—	—	—	—	56·12†	52·29†	—	—	—	—	—	—
	External Condyle, Hor. Band-Radius	20·0?	26·6?	—	—	—	—	—	—	—	—	18·90	16·81	—	—	—	—	—	—
	External Condyle, Vert. Band-Radius	22·4?	26·3?	—	—	—	—	—	—	—	—	20·82	18·48	—	—	—	—	—	—
	Height, Patellar Surface	24·0	16·7	—	25·8	[30·7??]‖	[19·5]	—	—	—	—	25·81†	22·87†	—	—	—	—	—	—
	Breadth, Distal Articulation	73·0?	69·5	—	82·2	[77·8??]	[64·0]	—	—	—	—	70·22†	62·25†	—	—	—	—	—	—
ANGLES	Midtrochlear Angle	8°·0	9°·6	8°·0	6°·7	8°·5	[8°·5]	—	—	—	—	7°·85	7°·73	—	—	—	—	—	—
	Angle at Centre of Head	48°·0	55°·4	46°·0	47°·3	43°·5	[51°·5]	—	—	—	—	41°·56	42°·72	—	—	—	—	—	—
	Collar Angle	124°·0	115°·0	126°·0	126°·0	128°·0	[120°·0]	128°·0	128°·0	124°·1	124°·1	130°·94	129°·85	128°·7	128°·7	124°·8	124°·8	123°·8	123°·8
	Torsion of Shaft	—	23°·4	25°·0	—	—	—	—	—	—	—	24°·26	25°·55	—	—	—	—	—	—
	Torsional Angle	15°·0	10°·2	15°·0	35°·0	—	—	29°·0	27°·0	18°·5	18°·5	13°·21	16°·13	19°·2	19°·2	18°·9	18°·9	19°·6	19°·6
	Retorsional Angle	—	13°·2	10°·0	—	—	—	—	—	—	—	11°·24	9°·28	—	—	—	—	—	—
	Obliquity of Shaft	12°·0	4°·0	8°·5	12°·5	10°·0	7°·9	10°·2	10°·5	—	—	10°·19	10°·61	—	—	10°·0	10°·0	9°·6	9°·6
	Pseudo-Obliquity	6°·6	6°·4	3°·7	6°·0	5°·0	5°·6	7°·8	8°·1	6°·3	6°·3	5°·81	7°·42	—	—	8°·0	9°·3	4°·0	4°·2
GENERAL INDICES	Oblique-Direct Lengths Index	99·3	99·3	99·8	99·2	99·6	99·5	99·3	99·0	99·4	99·4	99·36	99·25	—	—	98·9	98·7	99·7	99·7
	Oblique-Direct Troch. Lengths Index	98·9	99·8	—	98·6	99·4	99·2	—	—	—	—	99·49	99·36	—	—	—	—	—	—
	Proximal Breadth Ratio	21·1	25·1	[24·6?]	21·6	22·9	21·0	—	—	—	—	22·20†	21·92†	—	—	[22·1]	[22·1]	21·2	21·2
	Distal Breadth Ratio	17·8	21·6	[21·6??]	19·0	19·9	18·3	—	—	[18·2]	[18·2]	18·77	18·13	18·6	18·6	[19·1]	[19·1]	19·4	19·4
	Pithecoid Index	95·6	96·7	—	97·1	97·1	96·1	—	—	—	—	95·19	95·04	—	—	—	—	95·7	95·4
	Robusticity of Femur	12·7	14·3	[12·4?]	13·0	—	12·6	12·6	12·6	12·6	12·6	12·84	12·57	12·9	12·9	12·6	12·6	12·8	12·8
BUST INDICES	Robusticity of Head	19·7	25·0	23·3	21·5	23·4	19·9	20·6	20·6	20·3	20·3	21·02	20·17	21·6	21·6	21·0	21·0	21·5	21·5
	Ellipticity of Head	97·8	98·4	—	99·3	100·0?	104·9	99·2	99·2	99·9	99·9	98·86	99·10	99·5	99·5	99·8	99·8	99·4	99·4
	Ellipticity of Neck	—	84·5?	69·6?	—	—	74·2	74·0	74·0	77·6	77·6	75·69	76·92	—	—	80·9	79·6	83·3	83·3
	Secondary Index of Neck	—	60·2	50·0?	—	—	53·5	53·5	53·5	—	—	55·23	55·54	—	—	—	—	58·7	55·8
	Lemotic Index	11·4	11·1	11·3	11·1	12·6	11·5	11·5	11·8	11·4	11·4	12·06	11·68	12·5	12·5	11·8	11·8	11·7	11·7
	Head Bust Ratio	60·8	72·7	68·3	62·3	60·4	59·4	62·5	60·2	61·7	61·7	61·32	60·70	61·6	61·6	61·1	61·1	62·4	62·4
	Primary Bust Ratio	16·3	17·2	17·0	16·2	17·6	16·2	16·6	16·5	16·4	16·4	17·24	16·66	—	—	—	—	16·9	16·9
	Secondary Bust Ratio	16·4	17·7	17·5	16·4	17·7	16·3	16·7	16·7	16·5	16·5	17·35	16·78	17·3	17·3	17·2	17·2	17·0	17·0
	Bust Shaft Index	18·7	20·2	19·9	18·7	19·3	18·8	—	—	—	—	20·48	19·62	—	—	—	—	—	—
	Capital Ratio	9·9	12·4	11·6	10·2	10·3	9·6	10·5	10·0	10·4	10·1	10·49	10·03	10·8	10·5	10·5	10·4	10·7	10·6
	Capito-bicondylar Ratio	57·7	59·7	[55·9??]	57·6	56·0	54·7	[58·3]	[58·3]	[57·3]	[57·3]	59·02	58·22	56·3	58·1	—	—	57·2	57·2
	Epiphysial Ratio	94·9	83·0	[82·0??]	92·3	94·5	92·0	[93·3]	[92·1]	95·4	95·4	96·88	96·22	95·4	95·4	—	—	97·9	97·9
SHAFT INDICES	Platymeric Index	94·0?	77·6	66·7	73·0	82·8	86·4	76·1	72·6	76·1	76·1	85·22	82·87	80·7	80·7	73·9	73·9	68·6	68·6
	Pilastric Index	108·7	108·1	99·2	125·1	—	114·0	108·0	110·0	110·8	110·8	104·43	101·61	109·8	109·8	107·4	107·4	109·4	109·4
	Popliteal Index	88·9	79·4	69·2	81·0	80·0	—	[70·3]	[70·3]	[80·4]	[80·4]	70·84	67·92	[77·6]	[77·6]	—	—	—	—
	Index of Popliteal Skewness	—	107·6	105·1	97·3?	—	—	—	—	—	—	90·96	90·57	—	—	—	—	—	—
	Popliteal Pyramidal Index	24·0?	35·4	30·4	—	—	—	—	—	—	—	33·05	32·83	[45·4]	[45·4]	—	—	—	—
	Soffit Index	46·2	45·8	[50·9??]	51·5	48·4	45·3	[50·2]	[50·2]	[48·0]	[48·0]	49·99	50·86	[51·5]	[51·5]	—	—	—	—
	Index of Gracility (Upper)	83·1	82·4	73·9	79·3	82·3	84·7	[77·8]	[79·4]	[79·7]	[79·7]	88·83	88·61	85·5	86·4	—	—	72·7	74·7
	Index of Gracility (Lower)	76·7	70·3	58·9	72·0	70·5	72·7	73·0	72·9	—	—	71·04	70·75	—	—	—	—	—	—
	Index of Transverse Slenderness	7·0	7·8	7·3	6·4	7·1	6·8	—	—	—	—	7·43	7·28	—	—	—	—	—	—
	Index of Sagittal Slenderness	7·6	8·4	7·3	[8·2]	—	7·7	—	—	—	—	7·71	7·36	—	—	—	—	—	—
	Index of Proximal Taper	104·0?	87·2	90·8	76·8	—	89·5	[86·5]	[89·2]	[77·3]	[77·3]	91·92	92·12	[92·9]	[92·9]	—	—	77·6	77·0
	Index of Distal Taper	106·7?	105·5	118·3	87·3	—	—	—	—	—	—	95·97	95·98	—	—	—	—	[97·1]	[100·7]
	Popliteal Shaft Index	38·0	31·9	40·7	—	—	—	—	—	—	—	32·28	31·99	—	—	—	—	—	—
	Primary Index of Bowing	2·8	3·7	2·7	4·3	—	—	—	—	—	—	2·55	2·50	—	—	—	—	—	—
	Secondary Index of Bowing	48·7	53·5	67·1	43·1	—	—	—	—	—	—	36·85	41·13	—	—	—	—	—	—
CONDYLAR INDICES	Condylar Index	79·7	82·8	—	—	—	—	—	—	—	—	78·08	79·91	—	—	—	—	79·4	79·4
	Condylar Lengths Index	97·2	110·7	—	—	—	—	—	—	—	—	100·34	100·80	—	—	—	—	—	—
	Bicondylar Ratio	17·4	20·8	[20·8??]	18·4	19·0?	17·6	[18·0]	[18·0]	[17·2]	[17·2]	17·83	17·25	19·2	17·2	—	—	18·8	18·8
	Band-radial Index	112·0??	98·6??	—	—	—	—	—	—	—	—	111·94	110·78	—	—	—	—	—	—
	Condylar Troch. Index	14·2	17·9	—	—	—	—	—	—	—	—	14·67	14·48	—	—	—	—	16·0	15·4
	Distal Articulation Ratio	16·0?	16·5	—	15·5	[16·1?]‖	15·1	—	—	—	—	15·76†	15·29†	—	—	—	—	—	—
	Distal Articulation Index	93·6?	79·4	—	88·3	[85·6?]	85·3	—	—	—	—	89·57†	88·53†	—	—	—	—	—	—
	Rotular Ratio	5·3	3·95	—	5·42	[6·3?]	4·6	—	—	—	—	5·73†	5·62†	—	—	—	—	—	—
	Rotular Index	32·9	24·0	—	32·4	[34·7?]	30·5	—	—	—	—	36·76†	36·74†	—	—	—	—	—	—
	Diaphysial Rotular Ratio	6·1	4·7	—	6·3	[7·1?]	5·2	—	—	—	—	6·75†	6·61†	—	—	—	—	—	—

		RECENT MAN, SELECTED GROUPS AND RACES																	MEAN	
		AUSTRALIAN RACES				BLACK RACES						ASIATICS							RECENT MAN	
	Genus or species →	Moriori and Maori	Moriori and Maori	Australians	Australians	Negritos	Negritos	Melanesians	Melanesians	Negroes	Negroes	Andamans	Andamans	Indonesians, Malays and Polynesians	Indonesians, Malays and Polynesians	Japanese, Chinese, Ainos, Indo-Chinese	Japanese, Chinese, Ainos, Indo-Chinese	Turks	Mean Values of Selected Groups of Recent Man	Mean Values of Selected Groups of Recent Man
	Characters ↓ Sex ...	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♂	♀
MAJOR LENGTHS	Maximum Length	440·7	417·3	471·6	426·3	—	—	—	—	[451·7]	[415·7]	—	—	—	—	408·0	381·0	—	440·9	408·4
	Trochanteric Length	421·8	402·0	—	—	—	—	—	—	—	—	—	—	—	—	388·0	361·0	—	412·9	384·9
	Maximum Troch. Length	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	435·0	398·0
	Oblique Length	435·9	411·0	465·6	408·0	480·4	366·9	444·7	412·3	449·4	412·4	381·0	364·0	432·1	395·2	406·0	379·0	428·0	435·5	398·5
	Trochanteric Oblique Length	408·6	386·8	437·0	400·0	—	—	—	—	—	—	—	—	—	—	—	—	—	415·5	385·5
	Capito-trochlear Length	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	432·0	394·0
	Diaphysial Length	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	378·1	347·0
	Length of Shaft	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	377·0	348·0
BUST	Vertical Diameter of Head	44·9	41·4	44·1	[33·5]	47·6	36·4	43·7	40·5	44·3	40·7	39·8	35·1	44·2	41·1	44·9	42·2	47·1	45·1	40·7
	Horizontal Diameter of Head	—	—	—	—	47·6	36·4	43·7	40·5	44·2	40·6	39·3	34·7	44·2	41·1	44·7	43·0	46·8	44·7	40·4
	Min. Horizontal Diameter of Neck	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	26·5	23·4
	Min. Vertical Diameter of Neck	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	33·6	29·2
	Capito-collar Length	72·5	63·9	—	—	74·1	63·5	68·5	63·5	71·7	66·0	[74·3]	—	68·2	63·4	70·6	66·3	72·6	72·5	66·3
	Length of Neck	50·3	43·2	—	—	50·3	38·4	46·6	43·2	49·7	45·7	[53·6]	—	46·1	43·2	48·2	45·2	49·1	50·0	45·2
SHAFT	Proximal Breadth	—	—	81·8	72·0	—	—	—	—	[92·8]	[85·3]	—	—	—	—	—	—	—	88·8	80·9
	Platymeric A.P. Diameter	22·3	20·6	23·8	20·0	—	—	—	—	24·6	21·2	17·8	17·0	—	—	[23·5]	[20·3]	—	23·9	21·5
	Platymeric Trans. Diameter	34·2	33·2	30·7	23·0	—	—	—	—	31·3	27·7	23·0	21·2	—	—	[31·5]	[28·6]	—	31·3	28·2
	Pilastric A.P. Diameter	29·8	26·2	32·0	28·0	31·3	24·0	28·0	26·0	30·9	25·1	22·5	22·0	27·6	25·2	27·0	24·3	27·5	28·7	25·8
	Pilastric Trans. Diameter	25·1	24·3	28·2	23·5	27·0	20·7	24·4	22·6	26·7	22·8	20·4	18·5	24·9	22·8	26·0	23·7	26·0	25·9	23·4
	Popliteal Length	—	—	—	—	—	—	—	—	—	—	[116·9]	[120·8]	—	—	—	—	—	[119·3]	[115·9]
	Popliteal Width	—	—	—	—	—	—	—	—	35·7	33·2	[28·6]	[29·5]	—	—	—	—	—	36·0	33·9
	Popliteal Direct A.P. Diameter	—	—	—	—	—	—	—	—	30·3	24·6	[22·6]	[21·5]	—	—	—	—	—	28·0	24·6
	Popliteal Oblique A.P. Diameter	—	—	—	—	—	—	—	—	—	—	[22·4]	[23·8]	—	—	—	—	—	30·7	26·8
	Diaphysial Chord	—	—	—	—	—	—	—	—	—	—	—	—	—					252·7	227·4
	Diaphysial Subtense	—	—	—	—	—	—	—	—	—	—	—	—						6·5	[illegible]
	Proximal Segment, Diaphysial Chord	—	—	—	—	—	—	—	—	—	—	—							95·7	[illegible]
CONDYLES	Bicondylar Width	79·9	73·8	78·5	66·1	—	—	—	—	80·3	72·0	67·4	62·3	75·4	68·0	79·2	71·5		[illegible]	70·4
	Max. Length, External Condyle	—	—	—	—	[53·0]	[53·0]	—	—	—	—	—	—	58·5	52·4	—	—		[illegible]	56·2
	Max. Length, Internal Condyle	—	—	—	—	[53·0]	[53·0]	—	—	—	—	—	—	56·5	50·6	—	—		[illegible]	53·1
	Oblique Length, External Condyle	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		[illegible]	55·5
	Oblique Length, Internal Condyle	—	—	—	—	—	—	—	—	—	—	—	—	—	—				[illegible]	—
	External Condyle, Hor. Band-Radius	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		[illegible]	16·8
	External Condyle, Vert. Band-Radius	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		[illegible]	18·5
	Height, Patellar Surface	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		[illegible]	[illegible]
	Breadth, Distal Articulation	—	—	—	—	—	—	—	—	[75·7]	[67·1]	—	—	—	—	—	—		[illegible]	[illegible]
ANGLES	Midtrochlear Angle	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		[illegible]	[illegible]
	Angle at Centre of Head	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	[illegible]	[illegible]
	Collar Angle	130°·4	130°·4	119°·4	119°·4	132°·6	132°·6	132°·0	132°·0	127°·1	126°·1	[130°·0]	[130°·0]	128°·7	128°·7	126°·2	126°·2	[illegible]	[illegible]	[illegible]
	Torsion of Shaft	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		[illegible]	[illegible]
	Torsional Angle	39°·7	39°·7	—	—	23°·0	23°·0	22°·8	22°·8	17°·0	17°·1	0°·2	0°·2	21°·9	21°·9	13°·9	13°·9	[illegible]	[illegible]	[illegible]
	Retorsional Angle	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	[illegible]	[illegible]
	Obliquity of Shaft	9°·2	9°·2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9°·8	[illegible]
	Pseudo-Obliquity	8°·5	9°·0	—	—	—	—	—	—	—	—	—	—	—	—	5°·7	5°·9	—	6°·6	7°·2
GENERAL INDICES	Oblique-Direct Lengths Index	98·9	98·9	—	—	—	—	—	—	—	—	—	—	—	—	99·5	99·5	—	99·3	[illegible]
	Oblique-Direct Troch. Lengths Index	96·9	96·2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	98·2	[illegible]
	Proximal Breadth Ratio	—	—	18·6	17·9	—	—	—	—	—	—	[22·1]	[22·1]	—	—	[22·3]	[22·3]	—	21·3	[illegible]
	Distal Breadth Ratio	18·7	18·7	17·8	16·4	[18·0]	[18·0]	—	—	17·4	17·0	18·3	18·3	18·7	18·7	20·4	19·8	—	18·7	[illegible]
	Pithecoid Index	93·7	94·0	93·9	[98·0?]	—	—	—	—	—	—	—	—	—	—	—	—	—	94·6	[illegible]
	Robusticity of Femur	12·6	12·3	11·6	10·8	12·1	12·1	11·8	11·8	11·8	11·6	12·1	12·1	12·2	12·2	12·4	12·4	12·5	12·4	[illegible]
BUST INDICES	Robusticity of Head	20·5	20·5	19·9	[16·4]	19·8	19·8	19·6	19·6	19·7	19·7	18·9	19·1	20·5	20·5	21·6	21·6	21·9	20·6	[illegible]
	Ellipticity of Head	—	—	—	—	99·9	99·9	100·0	100·0	99·8	99·8	98·8	98·8	99·9	100·0	100·6	100·6	100·4	100·5	[illegible]
	Ellipticity of Neck	—	—	—	—	—	—	—	—	81·4	81·4	—	—	—	—	—	—	—	[illegible]	[illegible]
	Secondary Index of Neck	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	[illegible]	[illegible]
	Lemotic Index	12·2	12·2	—	—	10·5	10·5	10·5	10·5	11·1	11·1	[11·9]	[11·9]	10·7	10·7	11·5	11·5	11·5	[illegible]	[illegible]
	Head Bust Ratio	—	—	—	—	64·2	64·2	63·8	63·8	61·6	61·6	57·9	57·9	64·8	64·8	62·5	62·5	64·9	[illegible]	[illegible]
	Primary Bust Ratio	—	—	—	—	—	—	—	—	[15·9]	[15·9]	—	—	—	—	—	—	—	[illegible]	[illegible]
	Secondary Bust Ratio	—	—	—	—	15·4	15·4	15·4	15·4	16·0	16·0	16·8	16·8	15·8	15·8	16·8	16·8	17·0	[illegible]	[illegible]
	Bust Shaft Index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	[illegible]	[illegible]
	Capital Ratio	10·1	10·1	9·4	[8·2]	9·9	9·8	9·8	9·7	9·9	9·8	9·7	9·7	10·2	10·2	10·7	10·6	10·9	[illegible]	[illegible]
	Capito-bicondylar Ratio	56·3	56·1	56·2	[50·7]	—	—	—	—	57·1	55·7	54·4	57·0	58·6	60·4	56·7	59·0	—	[illegible]	[illegible]
	Epiphysial Ratio	97·7	97·7	98·0	[91·8]	93·4	93·4	—	—	90·7	90·7	95·3	95·3	90·5	93·2	89·1	92·7		[illegible]	[illegible]
SHAFT INDICES	Platymeric Index	63·1	63·1	82·2	82·2	81·7	81·7	79·3	79·3	83·5	83·5	78·0	78·0	74·2	74·2	75·7	75·7	73·3	77·3	77·3
	Pilastric Index	111·7	111·7	122·2	122·2	116·0	116·0	114·7	114·7	109·9	109·9	113·5	113·5	110·7	110·7	103·3	103·3	105·8	109·9	109·9
	Popliteal Index	[77·5]	[77·5]	[85·3]	[85·3]	—	—	—	—	81·8	81·8	[85·3]	[85·3]	—	—	—	—	—	77·2	77·2
	Index of Popliteal Skewness	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	90·8	90·8
	Popliteal Pyramidal Index	[39·5]	[39·5]	[30·5]	[30·5]	—	—	—	—	[33·0]	[33·0]	[26·6]	[26·6]	—	—	—	—	—	34·7	34·6
	Soffit Index	[48·8]	[48·8]	[44·9]	[44·9]	—	—	—	—	45·7	45·7	[43·9]	[43·9]	—	—	—	—	—	47·9	48·0
	Index of Gracility (Upper)	73·4	73·2	93·7	93·7	—	—	—	—	84·8	84·8	88·7	87·3	—	—	82·5	82·9	—	82·8	83·0
	Index of Gracility (Lower)	—	—	82·7	82·7	—	—	—	—	72·8	72·8	[71·3]	[62·7]	—	—	—	—	—	74·2	72·4
	Index of Transverse Slenderness	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7·4	7·3
	Index of Sagittal Slenderness	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7·7	7·4
	Index of Proximal Taper	74·8	78·6	74·4	71·4	—	—	—	—	79·6	84·5	79·1	77·3	—	—	87·0	83·5	—	82·1	82·4
	Index of Distal Taper	—	—	92·1	[84·8]	—	—	—	—	98·1	98·0	100·4	92·4	—	—	—	—	—	96·5	94·4
	Popliteal Shaft Index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	32·3	32·0
	Primary Index of Bowing	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2·6	2·5
	Secondary Index of Bowing	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	36·9	41·1
CONDYLAR INDICES	Condylar Index	—	—	—	—	—	—	—	—	—	—	76·9	76·9	75·9	75·9	—	—	—	78·0	78·0
	Condylar Lengths Index	—	—	—	—	—	—	—	—	—	—	—	—	103·6	103·6	—	—	—	101·5	101·5
	Bicondylar Ratio	17·[illegible]	17·4	16·8	[15·5]	—	—	—	—	16·9	16·7	17·6	17·0	17·8	17·6	19·3	18·8	—	17·9	17·4
	Band-radial Index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	111·3	111·3
	Condylar Troch. Index	—	—	—	—	13·4	13·4	—	—	—	—	13·9	13·9	14·6	14·6	—	—	—	14·8	14·6
	Distal Articulation Ratio	—	—	—	—	—	—	—	—	[16·8]	[16·1]	—	—	—	—	—	—	—	15·8	15·3
	Distal Articulation Index	—	—	—	—	—	—	—	—	[94·2]	[93·1]	—	—	—	—	—	—	—	89·6	88·5
	Rotular Ratio	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5·7	5·6
	Rotular Index	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	36·8	36·7
	Diaphysial Rotular Ratio	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6·7	6·6

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* Klaatsch gives (Bibl. 103 *bis*, S. 329) Condylus lat. Diam. longitudinalis R. 31, Condylus med. Diam. longitudinalis R. 34, L. 35. These figures can hardly refer to the condyle lengths.

† Deduced from 73 ♂'s and 62 ♀'s and not the entire material. For comparison we may note for this sample: Maximum Length ♂ 446·23, ♀ 408·56, and Bicondylar Width ♂ 78·42, ♀ 70·45, all fairly close to the total population values. We also formed the index, 100 patellar height/bicondylar width, ♂ 32·54, ♀ 32·53, showing like the Rotular Index very little sexual differentiation.

§ Reconstructed Grimaldi Type ♂: see text of this Chapter.

‖ Measurements so doubtful as to be hardly worth printing.

insignificant in the Grimaldi Type. It is scarcely traceable, or appears only as an anomaly, in Recent Man[1].

The general result of this examination of the popliteal curvature would seem to be that a common ancestor for Man and the Greater Anthropoids is indicated with a more orangoid than gibbon-like popliteal surface, and that we should side-track *Dryopithecus rhenanus* and *Prothylobates.* The individual who should stand at the branch-point of Orang, Man and Chimpanzee, the Prot-simio-human, and the links between this individual and *Procercopithecus* have yet to be found, but we have great doubt if they will show themselves gibbon-like in femoral characters.

If it is reasonable to pass from an orangoid popliteal area through a chimpanzee-like area to a gorilloid area, it does not seem less possible to pass from the orangoid popliteal area to the Neanderthal Type, thence through Galley Hill to the Cromagnon Type, and so (possibly through the Grimaldi Type) to Recent Man. Such a progress, however, marks a slight reversion of Recent Man to a more apelike form, corresponding to what has been already noted in several other femoral characters.

The general conclusion we should draw from this brief examination of the human femoral anomalies is distinctly against such a complex femur as the human having passed at all through such a slender simple form as we must, from our knowledge of the present gibbon and of its fossil representatives, credit the *Prothylobates* with possessing. We feel forced to discard the primate pedigrees of both Haeckel and Dubois, and we reject the hypothesis that the Trinil femur can be a link between those of Primogenial Man and of a *Prothylobates.* If an ancestor of man ever reached a thigh bone in the stage of the Trinil femur, he was, as far as that bone is concerned, Recent Man, and Palaeolithic Man interpolated between two epochs of Recent Man seems incomprehensible[2].

(*b*) *Arguments based on quantitatively measured Characters.* We must now turn to the measurements recorded in our tables of the Anthropoids, Primogenial Man and Recent Man. In the first place we believe that very little weight can be given to absolute size in the question of determining the links of a pedigree. There is no doubt that size decreases as we go backward in the general Simian pedigree, although there are exceptions as the case of recent and fossil gibbons[3]. If the reader

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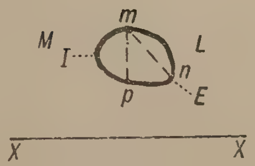
[1] The central trough of the anterior face, which does not usually go as far as the popliteal section, is possibly a vestige of the "tongue" and ultimately of the long patellar articular surface which we find in certain of the lower primates. The extension of this trough on the mesial side of the anterior face is what we note in Primogenial Man; it is emphasised by exaggerated elevation of the lateral side of the anterior face in this region.

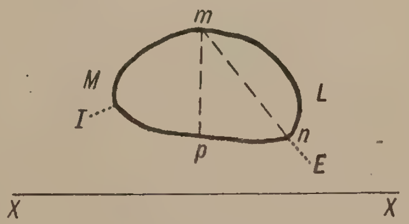
[2] The only explanation would be a periodicity in environment in which the essential need of strength alternated with a need for extreme agility.

[3] This degradation tends to confirm the view that the Gibbon evolution has been a continuous one in the direction of increased lightness and agility. A somewhat similar development of the femur is found in *Ateles.* If we look upon the Gorilla as the product of an essential need for strength, and Man as a case in which neither agility nor strength alone has dominated, it need not surprise us to find in the Gibbon certain human features, and we may even accept without much hesitation the statement that *Ateles* is the most human of South American apes. But the pedigree-maker who places *Hylobates* at the base of the anthropoids, might with equal legitimacy claim an *Ateles* as the parent of the *Cebidae.* The simplicity and

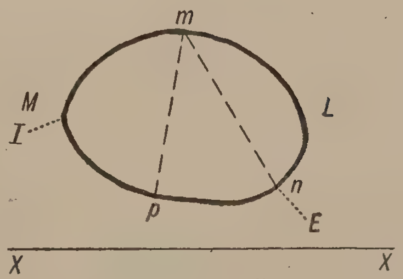
Popliteal Sections of Femora of *Homo Primogenius* and Anthropoids



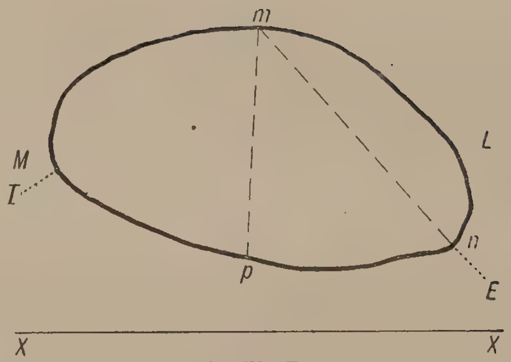
Gibbon R.



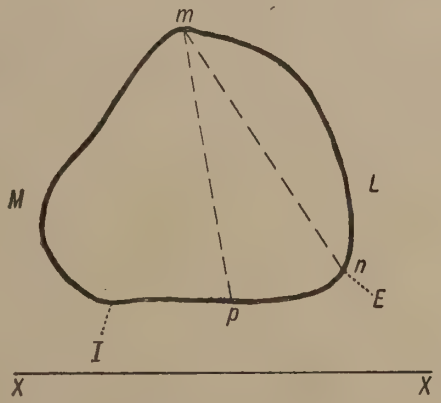
Orang R.



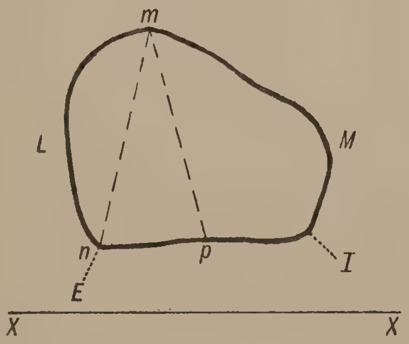
Chimpanzee R.



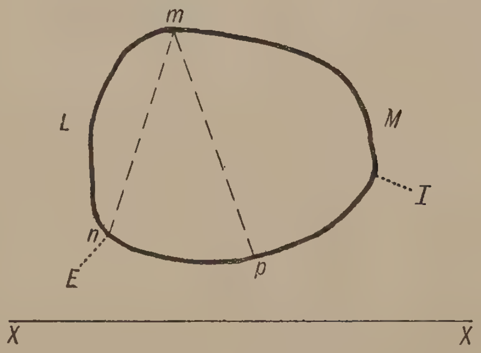
Gorilla R.



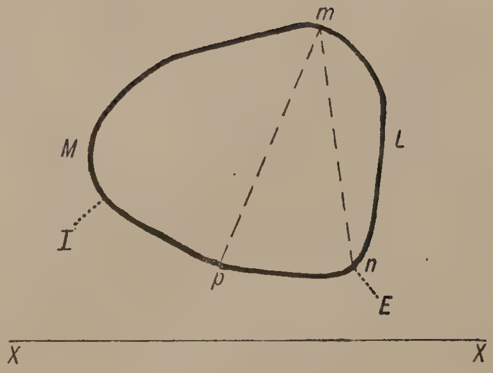
Cromagnon R. (from cast).



Tilbury L. (from cast).



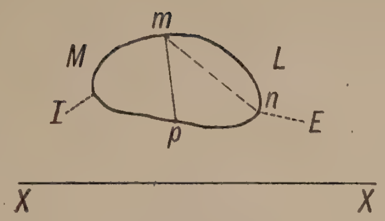
Neanderthal L. (from cast).



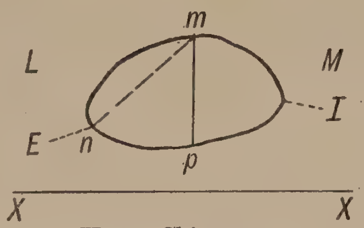
Spy R. (from cast).

E and *I*, external and internal supracondylar ridges as closely as they can be determined.
XX is parallel to trace of Standard Vertical Plane on Plane of Popliteal Section ($\frac{1}{10}$ diaphysial length from patellar articular border).

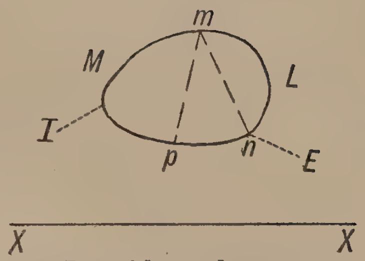
POPLITEAL SECTIONS OF INFANT ANTHROPOIDS, PRIMOGENIAL MAN AND RECENT MAN



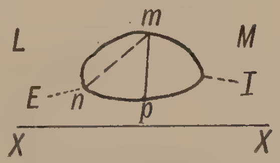
Infant Gorilla.



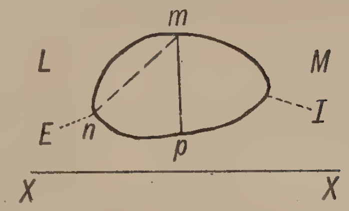
Young Chimpanzee.



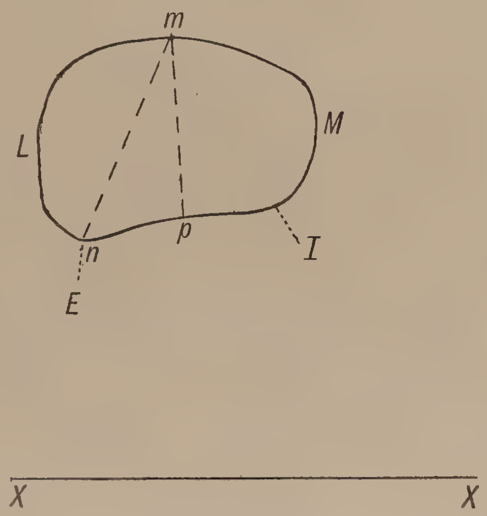
Dryopithecus rhenanus
(Eppelsheimer Femur from cast).



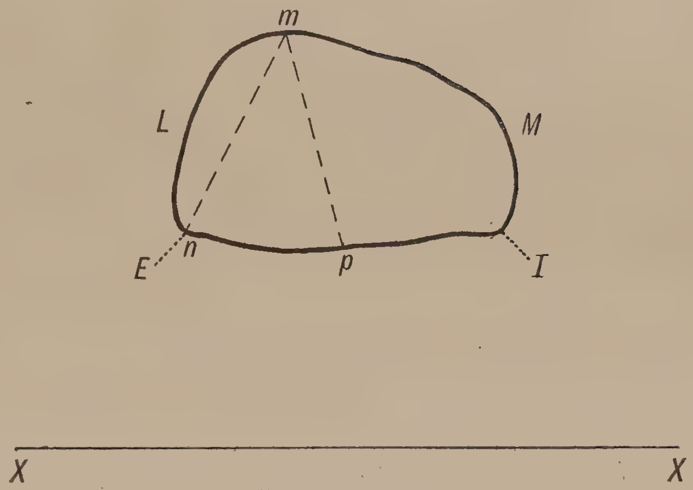
Infant Orang-utan.



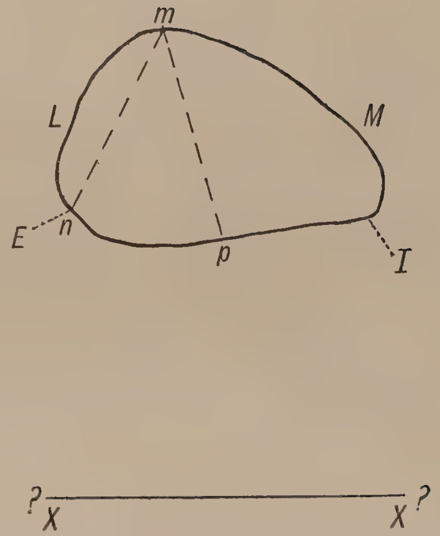
Infant Chimpanzee.



Recent Man.



Galley Hill Man.



Homo mousteriensis (*Hauseri*) (from cast. Note the divergence from Fig. 7, p. 15, where the section was taken by the 4 cms. rule).

E and *I*, external and internal supracondylar ridges as closely as they can be determined.
XX = trace of Standard Vertical Plane on Plane of Popliteal Section ($\frac{1}{10}$ diaphysial length from patellar articular border).

will examine the Plate (LXVI) of the femora of *Dryopithecus rhenanus* and of *Hylobates mülleri*, he will be convinced that mere size does not define a group. The indices of both femora are in striking accordance if the absolute sizes are so different. Again, Plates LXIII and LXIV show anterior and posterior aspects of the femora of Orang, Mousterian Man and a primitive type of Recent Man. The size change from Mousterian Man to Recent Man is not more marked than the size change from Orang to Mousterian Man. A size change alone does not stand as a bar to a close relationship. Two races of dogs which bred intraracially have been true to a *small* femur—the one, if we may say so, orangoid and the other gibbon-like—may when cross bred give rise to a certain number of individuals, with relatively large femora, such as neither breed has exhibited in a long known pedigree. If this can occur in two or three generations, we cannot pay much attention to mere size when dealing with a pedigree extending over thousands of years. Accordingly we propose to deal only with indices in searching for light on the pedigree of man.

The method adopted will be a simplified form of that which we intend to apply to the primates as a whole, except that for simplicity we shall neglect the correlations of the characters dealt with and at certain stages use mean deviations instead of the more appropriate standard deviations. The actual numerical evaluation of position will accordingly be subject to some modifications when the whole of the primates are considered and these simplifications discarded. We consider the following: *Simiadae* and *Hominidae*, Gibbon, *Dryopithecus rhenanus*, Gorilla, Chimpanzee, Orang, *Pithecanthropus erectus*, Neanderthal Man, Recent Man. This may appear at first sight to give an undue numerical superiority to Man, but Neanderthal Man is almost as far removed from Recent Man, as the Gorilla from the Chimpanzee, and although we ourselves look upon *Pithecanthropus erectus, as far as it is represented by the Trinil femur*, merely as an individual case of Recent Man, we feel compelled to give it an individual position because some will not agree with this view. Thus *Pithecanthropus* and *Dryopithecus* differ from the other members of the group in being represented by single bones, and the positions of their species are therefore subject to very large errors, as will be realised by any one conversant with the wide limits of variation in the femur of the same species. It would be absurd, however, to weight *Pithecanthropus* and *Dryopithecus* with one each and Recent Man with 400! We have in each case used male values where they were available and our 17th century Londoners as the most reliable series have been used to represent Recent Man. For each index a mean was found for the eight species, this shall be termed the simio-human mean; further the standard deviation was found of the eight species, in order to obtain a rough measure of the degree of variation in each character. The deviation of each species for each index character from the corresponding simio-human mean was then measured in terms of the corresponding standard deviation. We thus obtain comparable measures of all the characters independent of the degree of variation of the absolute index. We shall term these values *reduced indicial deviations*. If two reduced indicial deviations be

lightness of the femora in both *Hylobates* and *Ateles* are not marks of primitiveness, but of a differentiation dictated by the essential need for agility.

subtracted we obtain what may be termed an *interspecial deviation*. Thus the interspecial deviation for the pithecoid index in Man and the Gorilla is the difference of their pithecoid indices divided by the standard deviation of the pithecoid index in the simio-human group. Further if we take the mean of the interspecial deviations without regard to sign for two species for any set of characters, we obtain what is clearly a reasonable measure of the approximation of these two species for the group of characters in question. We shall term this the *Mean Interspecial Difference* for the group of characters for the two species. A comparison of Mean Interspecial Differences ought to throw considerable light on the degree of resemblance of the femora of various species of Man and apes and by fixing their affinities enable us to see a little further into the simio-human pedigree.

We shall in the investigation occasionally refer to *Tarsius spectrum*, because it has recently been suggested that this species is closer to Man than the Anthropoids.

We take first:

(1) *General Indices of the Femur.*

The following table gives the reduced indicial deviations for the six indices of this group.

SUBTABLE VIII. *Reduced Indicial Deviations. General Indices.*

Index	Simio-human		Gibbon	*Dryo-pithecus*	Gorilla	Chim-panzee	Orang	*Pithecan-thropus*	Neander-thal Man	Recent Man	*Tarsius spectrum*
	Mean	S. D.									
Oblique Direct Lengths Index	99·53	·2947	1·595	·916	·916	−1·459	·238	− ·781	−·781	−·611	1·086
Obl. Dir. Troch. Lengths Index	99·76	·3935	·588	·343	·588	1·324	− ·147	−2·108	·098	−·637	·343
Proximal Breadth Ratio ...	22·32	4·2208	−1·734	−1·118	1·310	− ·040	1·227	− ·289	·659	−·017	−2·113
Distal Breadth Ratio ...	19·49	3·9053	−1·624	−1·278	1·398	·707	·873	− ·433	·540	−·190	−2·226
Pithecoid Index	97·44	2·6495	·702	·664	1·287	·966	−1·789	− ·694	−·279	−·845	·808
Robusticity of Femur ...	13·81	2·5742	−1·713	− ·587	1·977	·521	·423	− ·431	·190	−·373	−1·519
Mean Indicial Deviation ...	—		1·326	·818	1·246	·836	·783	·789	·421	·445	1·349
Mean Indicial Deviation having regard to sign			− ·364	− ·177	1·246	·337	·138	− ·789	·071	−·445	− ·604

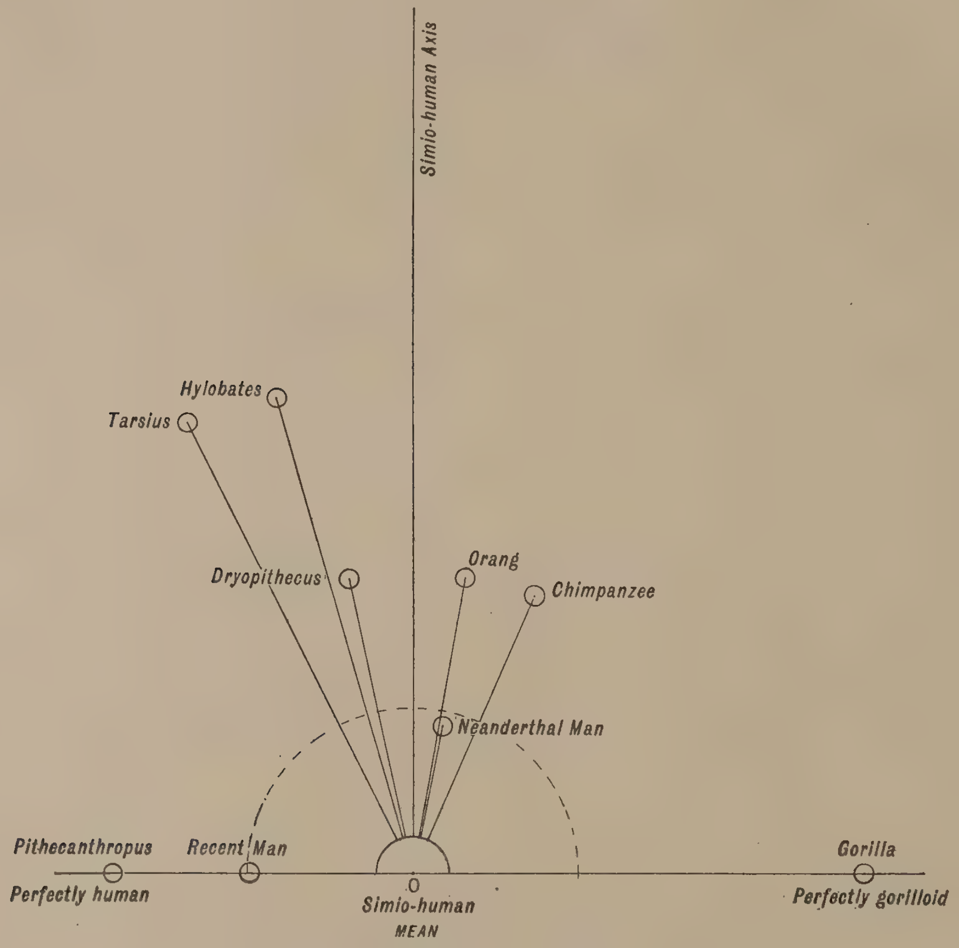
This table is of considerable interest; it shows that the Gorilla has all its six indices in excess of the simio-human means, while Recent Man as well as *Pithecanthropus* have *all* their six indices in defect of the simio-human means. Thus for these indices the interpretation of what is "gorilloid" and what is "human-like" is easy—it means excess or defect on the simio-human means. Accordingly if we take the mean individual deviation, *having regard to sign*, we get a rough appreciation of the extent of the human character in the species. Thus Recent Man and *Pithecanthropus* have the maximum human-like values, *Dryopithecus*, *Hylobates* and *Tarsius* are on the human side, Neanderthal Man is nearly a transition form, being slightly gorilloid, while Orang and Chimpanzee are stages to the complete gorilloid character of the Gorilla itself. If we take:

$$\sin\theta = \frac{\text{Mean Indicial Deviation having regard to sign}}{\text{Mean Indicial Deviation}},$$

$\sin\theta$ will lie between -1 for Man and $+1$ for the Gorilla, and θ between $-\frac{1}{2}\pi$ and $+\frac{1}{2}\pi$ will be a reasonable measure for this feature.

If along lines radiating from the "simio-human point" as origin we plot rays r at angle θ, such that $r =$ Mean Indicial Deviation, we obtain a diagram indicating the general nature of the above table.

Diagram A.



General Indices of Femur. Scale 5 mm. = ·1.

If we assume the Simio-human Mean to be a general indication of where the Prot-simio-human is most likely to have been, we see that this form, *as far as the general indices of the femur are concerned*, was far removed from *Hylobates* in either its recent or fossil forms; its nearest resemblance is to Neanderthal Man and then to Recent Man, while the Orang and Chimpanzee are not as far removed as either *Hylobates* or the Gorilla. In other words the suggestion is that the general proportioning of the prot-simio-human femur was far more human than we have hitherto given it credit for being—a Neanderthalloid femur weakened in the orangoid direction. *Tarsius* is as much out of the question as the Gorilla itself.

Let us examine this matter again without any hypothesis as to the simio-human means being a rough measure of the prot-simio-human femur. We can achieve this best by measuring the mean degree of resemblance of the other members of the group to Recent Man, Neanderthal Man and *Pithecanthropus erectus.* The following are the orders of resemblance in these cases as determined by the mean Interspecial Differences.

SUBTABLE IX. *Resemblance of Apes to Man.*

Pithecanthropus erectus		Neanderthal Man		Recent Man	
Recent Man	·394	Recent Man	·573	*Pithecanthropus erectus*	·394
Neanderthal Man ...	·861	Orang	·651	Neanderthal Man ...	·573
Orang	1·292	Chimpanzee	·724	Orang	·898
Chimpanzee	1·352	*Pithecanthropus erectus*	·861	*Dryopithecus rhenanus*	1·070
Dryopithecus rhenanus	1·366	Gorilla	1·175	Chimpanzee	1·072
Hylobates	1·731	*Dryopithecus rhenanus*	1·209	*Hylobates*	1·578
Tarsius spectrum ...	1·755	*Hylobates*	1·716	*Tarsius spectrum* ...	1·603
Gorilla	2·035	*Tarsius spectrum* ...	1·733	Gorilla	1·691

Now these results we venture to think of much interest. The order for *Pithecanthropus* and Recent Man is the same; both are nearer to Neanderthal Man than to any other primate, then come the Orang and Chimpanzee, closely followed by *Dryopithecus rhenanus* and then with much smaller degree of resemblance by Recent Gibbon, *Tarsius* and the Gorilla. *Tarsius* is nearly twice as remote from Recent Man as the Orang for the General Indices of the femur. The Trinil femur is seen to be widely divergent from that of *Hylobates*; it exhibits no more deviation from Recent Man than any individual recent femur might do and it is closer to Neanderthal Man and then to the Orang and Chimpanzee than to fossil or Recent Gibbon.

In the case of the Neanderthal Type, it is closest to Recent Man, but it resembles the Orang, Chimpanzee and the Gorilla (owing to its more marked gorilloid features) very much closer than Recent Man does. In fact our results are in good agreement with our previous method of approach and confirm the view that for these General Indices, we must look for a human ancestral femur more of the Orang-Chimpanzee Type than of the *Hylobates* Type.

The reader may be interested in seeing the order of the Mean Interspecial Differences for *Tarsius.*

Hylobates	·339
Gorilla	·497
Dryopithecus rhenanus	·532
Recent Man	1·603
Neanderthal Man ...	1·716
Pithecanthropus erectus	1·755
Chimpanzee	1·788
Orang	2·053

It is difficult to note in this order any special relation of *Tarsius* to Recent or Palaeolithic Man. It seems rather to mark the relative distances the *Anthropoidea* have travelled from an original lemuroid stock; in the General Indices of the femur the Gibbon is *five* times as close as Man is to *Tarsius*. The appearance of certain lemuroid features as anomalies in the human femur—third trochanter lateral projection, frontal pilaster—which we are not familiar with in Orang and Chimpanzee, may even justify the greater remoteness of these apes from *Tarsius*.

(2) *Indices of the Shaft.*

We proceed in precisely the same way as for the General Indices, forming first the Table of Reduced Indicial Deviations.

SUBTABLE X. *Reduced Indicial Deviations. Indices of the Shaft.*

Index	Simio-human		Gibbon	*Dryopithecus*	Gorilla	Chimpanzee	Orang-utan	*Pithecanthropus*	Neanderthal Man	Recent Man	*Tarsius spectrum*
	Mean	S.D.									
Platymeric Index	84·52	5·9775	– ·137	1·168	·189	– ·120	– 1·643	1·586	– 1·158	·113	·624
Pilastric Index	96·81	11·6886	·971	·128	– 1·276	– 1·199	– 1·259	1·016	·966	·654	1·623
Popliteal Index	70·76	10·7716	·690	– ·674	– 1·824	– ·233	– ·451	1·683	·802	·008	3·326
Index of Popliteal Skewness	102·98	15·2982	– ·234	– 1·503	1·976	·276	– ·031	—	·302	– ·787	1·118
Soffit Index	50·85	5·8568	– 1·178	1·784	1·408	– ·222	·009	– ·794	– ·862	– ·145	– 1·135
Index of Gracility (Upper)	90·06	7·7460	– 1·124	– ·382	1·754	1·115	·676	– ·899	– ·989	– ·156	– ·873
Index of Gracility (Lower)	73·48	3·4346	1·593	– 1·188	– ·984	·515	·763	·938	– ·926	– ·708	6·281
Index of Trans. Slenderness	8·34	2·1381	– 1·562	– ·673	1·875	·800	·870	– ·627	– ·253	– ·416	– 1·632
Index of Sagittal Slenderness	7·86	1·2589	– 1·954	– ·683	1·779	·349	·429	– ·207	·429	– ·127	– 1·795
Index of Proximal Taper ...	97·86	5·9832	– ·444	1·243	·575	·750	– ·378	1·026	– 1·781	– ·996	– 1·330
Index of Distal Taper ...	99·28	7·8871	– ·987	– 1·189	– 1·253	1·302	·814	·941	·789	– ·422	– ·644
Primary Index of Bowing ...	2·22	1·2857	– 1·843	– 1·260	·996	·568	– ·327	·451	1·151	·257	– 2·699
Mean Indicial Deviation ...	—		1·060	·990	1·324	·621	·6375	·924	·867	·399	1·923
Mean Indicial Deviation paying attention to sign ...			– ·517	– ·269	·435	·325	– ·044	·426	– ·1275	– ·228	·2387

The results of this table are again of considerable interest. Forming $\sin\theta =$ Mean Indicial Deviation having regard to sign/Mean Indicial Deviation and deducing θ we have prepared a diagram as before.

We see again that Recent Man is nearer than any anthropoid to the Simio-human Mean. Instead of *Pithecanthropus* and Neanderthal Man coming next we find the Orang and Chimpanzee have replaced them, the orders being:

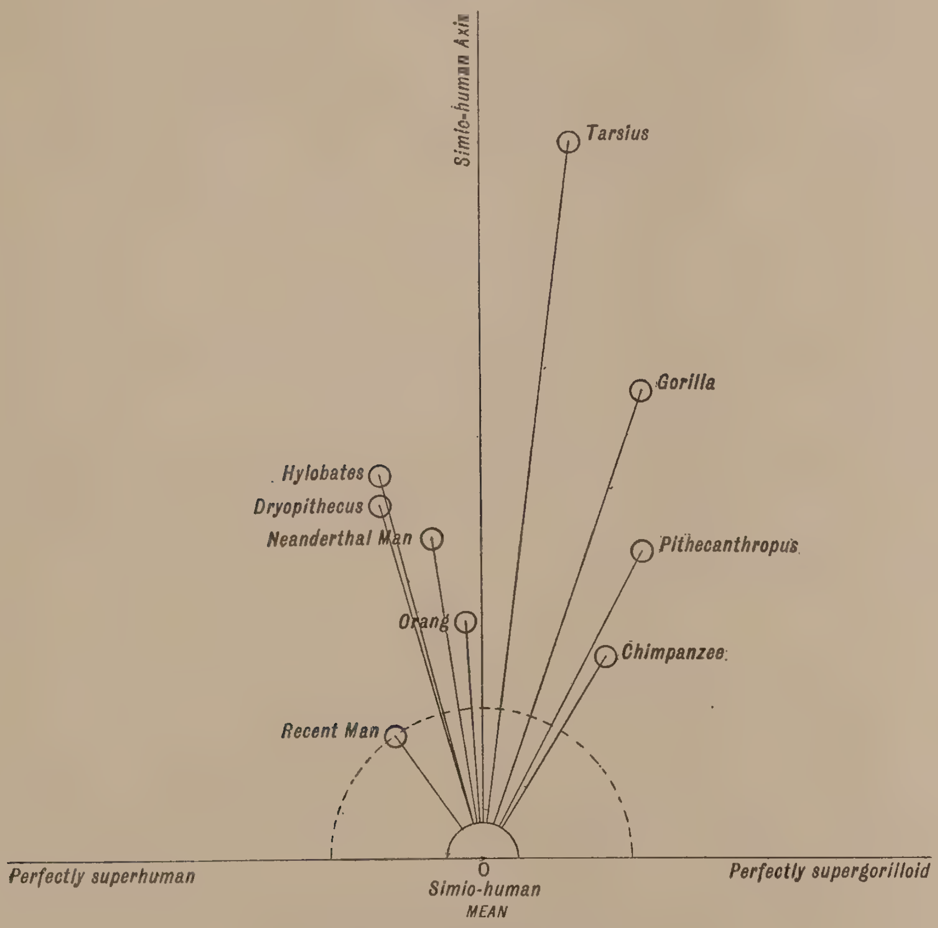
Orders of Mean Indicial Deviations.

General Indices of Femur		Indices of Shaft	
Neanderthal Man ...	·421	Recent Man	·399
Recent Man	·445	Chimpanzee	·621
Orang-utan	·783	Orang-utan	·637
Pithecanthropus erectus	·789	Neanderthal Man ...	·867
Dryopithecus rhenanus	·818	*Pithecanthropus erectus*	·924
Chimpanzee	·836	*Dryopithecus rhenanus*	·990
Gorilla	1·246	*Hylobates*	1·060
Hylobates	1·326	Gorilla	1·324
Tarsius spectrum ...	1·349	*Tarsius spectrum* ...	1·923

Now the General Indices are of course largely dependent on the shape of the shaft and these two orders indicate that the Gorilla and the Recent Gibbon have the least shaft resemblance to the mean simio-human shaft. They may be reasonably supposed therefore to have developed furthest from the prot-simio-human form. The fossil Gibbon (*Dryopithecus rhenanus*) is nearer than the Recent Gibbon to the Prot-simio-human, but it is clearly on the whole the Orang-utan and Chimpanzee shafts which follow the several human types in approximating to the Simio-human Mean.

Examining the table we note that there are for the indices of the shaft no individuals with all their indices less than those of the Mean Simio-human, and no individual with all its indices greater. Thus we cannot call the lines at $\theta = \pm 90^\circ$ the Axes of perfect human and perfect gorilloid characters, because Man and the Gorilla no longer lie upon them. Still it may be convenient to speak of them as the perfect "supergorilloid" and the perfect "superhuman" axes, the initial line for the measurement of θ being the perfect simio-human axis. In the case of both the general and the shaft index charts the Orang is closest to this simio-human axis; and for the Indices of the Shaft the *Hominidae* and *Anthropoidea* diverge less than is the case for the General Indices from the perfect simio-human axis towards the perfect super-

Diagram B.



Indices of Shaft. Scale 5 mm. = ·1.

human and supergorilloid axes. The position of *Pithecanthropus* is somewhat anomalous, but then this position is probably due to the measurements being those for a single individual, and one for which the measurements are at present largely guess-work.

We now turn to the second method of looking at the problem and measure the degree of resemblance of Recent Man, Neanderthal Man and *Pithecanthropus erectus* to the other individuals of the group.

We have the following orders:

Subtable XI. *Mean Interspecial Differences of Men and Apes.*

Pithecanthropus erectus		Neanderthal Man		Recent Man	
Chimpanzee	·930	Recent Man	·737	Neanderthal Man ...	·737
Neanderthal Man ...	·942	*Pithecanthropus erectus*	·942	*Dryopithecus rhenanus*	·912
Recent Man	·947	Orang-utan	1·046	*Pithecanthropus erectus*	·947
Dryopithecus rhenanus	1·149	Chimpanzee	1·101	Chimpanzee	·953
Orang-utan	1·206	*Hylobates*	1·204	Orang-utan	·968
Hylobates	1·435	*Dryopithecus rhenanus*	1·575	*Hylobates*	1·024
Gorilla	1·660	Gorilla	1·749	Gorilla	1·473
Tarsius spectrum ...	1·995	*Tarsius spectrum* ...	1·893	*Tarsius spectrum* ...	1·816

We see from these results that the Chimpanzee and the Orang are nearest of the existing Anthropoids to any form of Man—considerably nearer than the Gibbon or Gorilla. *Tarsius* stands well outside all the Anthropoids and has no close resemblance of any kind to the simio-human group. On the other hand the Eppelsheimer femur—as far as the shaft is concerned—resembles the human femur closer than the Trinil femur and is only excelled by that of Neanderthal Man. This was not, however, true for the General Indices of the femur.

(3) *Indices of the Bust.*

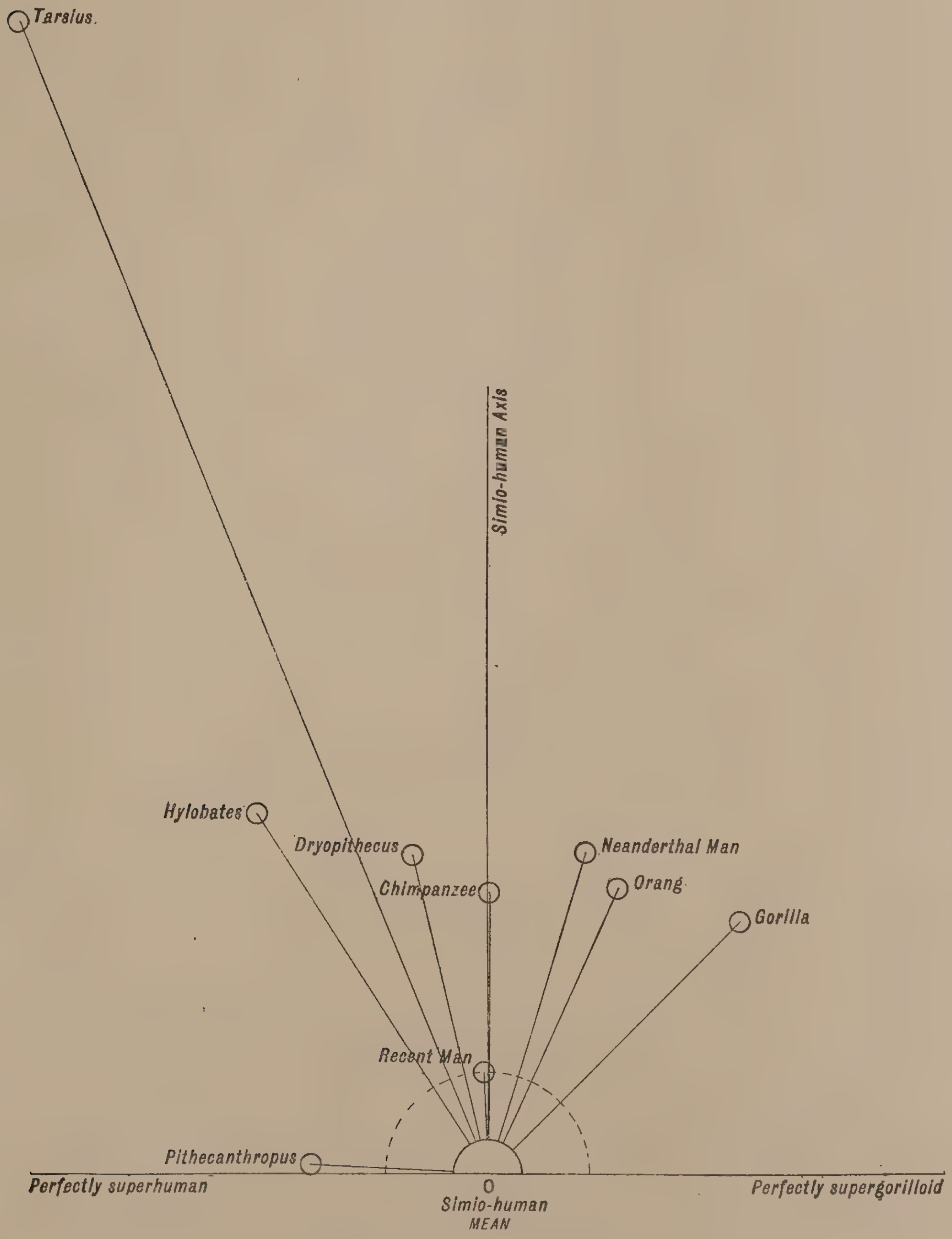
We now turn to consider how far these orders are confirmed, if we take into account the shape of the epiphyses as well as that of the diaphysis.

Subtable XII. *Reduced Indicial Deviations. Indices of Bust.*

Index	Simio-human		Gibbon	*Dryo-pithecus*	Gorilla	Chim-panzee	Orang-utan	*Pithecan-thropus*	Neander-thal Man	Recent Man	*Tarsius spectrum*
	Mean	S. D.									
Robusticity of Head ...	21·77	4·0143	−1·549	−1·263	1·452	·356	·904	− ·516	·805	−·192	−2·437
Ellipticity of Head ..	99·32	·8757	1·576	·320	·263	·948	·206	−1·736	−1·051	−·537	10·027
Ellipticity of Neck ...	78·53	4·3153	− ·656	1·522	·039	− ·285	−1·351	—	1·383	−·656	−4·722
Secondary Index of Neck	53·13	5·7647	− ·552	1·157	·324	− ·803	−1·723	—	1·227	·368	·108
Lemotic Index	12·44	2·0519	−1·408	− ·779	1·735	·858	·955	− ·507	− ·653	−·190	−3·747
Head Bust Ratio ...	61·08	4·8514	− ·604	−1·191	− ·058	− ·645	·107	− ·058	2·395	·045	3·147
Primary Bust Ratio ..	17·81	2·8854	−1·529	− ·939	1·730	·707	·967	− ·523	− ·211	−·194	−3·521
Secondary Bust Ratio ...	17·96	2·8955	−1·575	− ·953	1·689	·722	·946	− ·539	− ·090	−·211	−3·596
Bust Shaft Index ...	21·09	4·0430	−1·543	− ·962	1·499	·781	1·190	− ·591	− ·220	−·146	−3·227
Capital Ratio	10·87	1·9870	−1·570	−1·243	1·475	·317	·921	− ·488	·770	−·186	−2·577
Capito-bicondylar Ratio	57·69	2·5585	·668	·277	−1·051	−2·145	·942	·004	·786	·473	−1·598
Epiphysial Ratio ...	95·26	6·8192	1·142	1·516	− ·625	− ·771	·343	− ·053	−1·797	·240	−3·659
Mean Indicial Deviation	—		1·181	·928	·995	·778	·880	·502	·949	·287	3·531
Mean Indicial Deviation paying attention to sign ...			− ·633	− ·213	+ ·706	+ ·003	+ ·367	− ·501	+ ·279	−·099	−1·317

We obtain exactly as before a diagram for the Indices of the Bust. We see that Recent Man and *Pithecanthropus* are nearest to the Simio-human Mean, then follow Chimpanzee and Orang, and even *Dryopithecus* is interpolated between these and Neanderthal Man, and is almost as remote as the Gorilla. *Hylobates* is most removed, while *Tarsius* in degree of close resemblance to anthropoids and men is an *affaire pour*

Diagram C.



Indices of Bust. Scale 5 mm. = ·1.

rire. If we could suppose that the simio-human mean in any way represents an ancestor of the simio-human group this diagram would go far to confirm the opinion held by some that Neanderthal Man was not a direct ancestor of Recent Man.

Turning to the mean interspecial differences we have the following resemblance orders for the bust:

SUBTABLE XIII. *Mean Interspecial Differences of Men and Apes.*

Pithecanthropus erectus		Neanderthal Man		Recent Man	
Recent Man	·411	Recent Man	·895	*Pithecanthropus erectus*	·411
Dryopithecus rhenanus	·803	*Pithecanthropus erectus*	·952	Neanderthal Man	·895
Neanderthal Man	·952	*Dryopithecus rhenanus*	1·296	Orang-utan	·930
Hylobates	1·174	Orang-utan	1·417	*Dryopithecus rhenanus*	·964
Orang-utan	1·250	Chimpanzee	1·487	Chimpanzee	1·017
Chimpanzee	1·404	Gorilla	1·517	*Hylobates*	1·070
Gorilla	1·636	*Hylobates*	1·840	Gorilla	1·227
Tarsius spectrum	3·009	*Tarsius spectrum*	3·567	*Tarsius spectrum*	3·496

The close relation in the femoral bust of Recent Man and *Pithecanthropus erectus* is again brought out—the resemblance is double that of either to Neanderthal Man. The Gorilla is remote, as remote as *Hylobates,* to Recent or Primogenial Man. The Orang and Chimpanzee are closer than Gorilla and *Hylobates.* The position of the Eppelsheimer femur deserves again a word of comment. We ought not to compare its position in the series with that of the Orangs and Chimpanzee *directly.* They are "recent," and a sort of proportional sum ought to be worked out mentally, *i.e.* as the position of the fossil Gibbon *Dryopithecus rhenanus* is to the position of the Recent Gibbon, such would be the position of the fossil Chimpanzee or Orang—if we had either—relatively to the Recent Chimpanzee or Orang. Only such a proportional change could place the Orang-Chimpanzee relationship to Man in its fitting position[1]. Notwithstanding the position of *Dryopithecus rhenanus* we must refuse to place the Gibbon in a closer relation to Man than the Orang and Chimpanzee.

(4) *The Indices of the Distal Epiphysis.*

If we examine our separate tables we see that Recent Man is nearest to the Simio-human Mean in the characters of the bust, is most remote in the characters of the distal epiphysis and that the characters of the shaft and the general indices are intermediate. In other words the characters of head and neck in the human femur are probably most primitive and those of the distal epiphysis most developed. This is in accordance with our discussion of the patellar articular surface (see p. 424 *et seq.*). It is of special note that the Chimpanzee after Man has changed least from the Simio-human Mean. The Orang for this region of the femur has developed even more than

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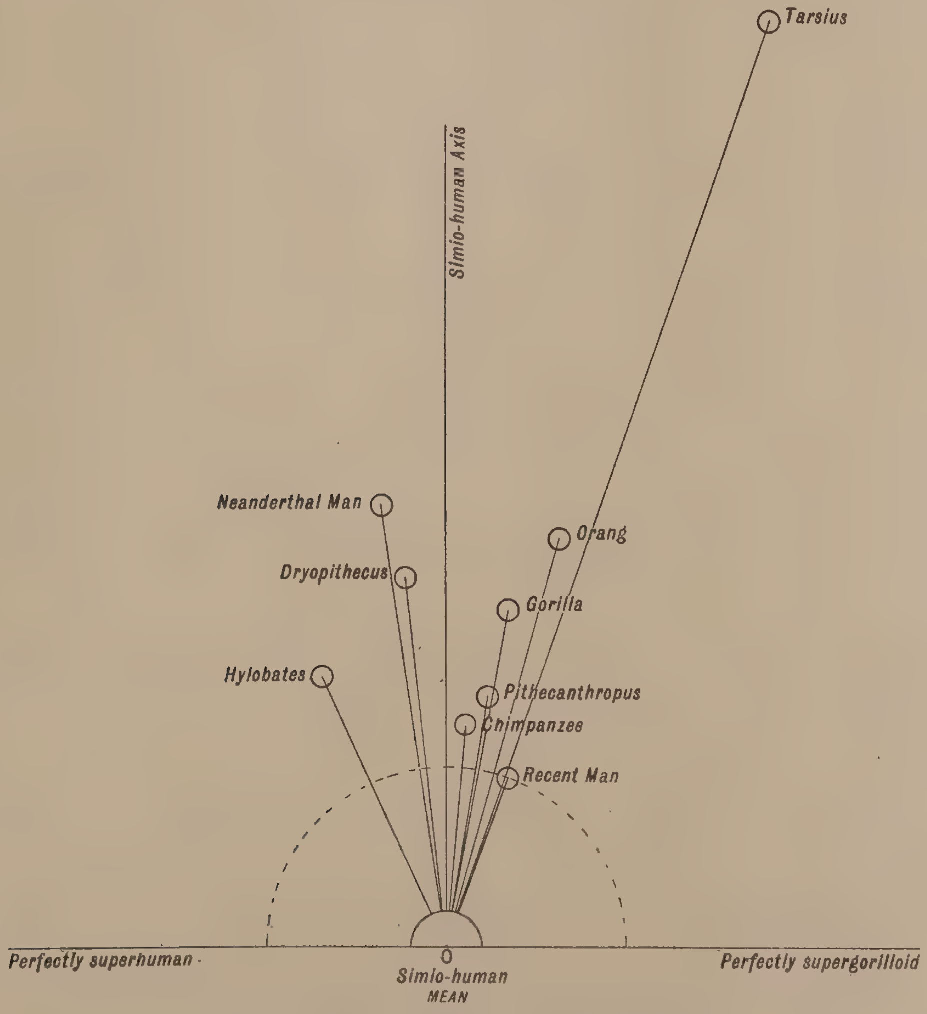
[1] We have little hesitation in asserting that if a fossil Chimpanzee femur were found it would be much closer to the human femur than that of the Recent Chimpanzee. Having measured many thousands of teeth in various races of Man, we believe that possibly too little stress has been laid on the range of the variation and too great stress on teeth differences in classifying fossil primates isolated by mandible fragments. The discovery of a fossil femur of *Palaeopithecus sivalensis* or of *Sivapithecus indicus* would be of intense interest.

SUBTABLE XIV. *Reduced Indicial Deviations. Indices of Distal Epiphysis.*

Index	Simio-human Mean	Simio-human S. D.	Gibbon	*Dryo-pithecus*	Gorilla	Chim-panzee	Orang-utan	*Pithecan-thropus*	Neander-thal Man	Recent Man	*Tarsius spectrum*
Condylar Index	72·47	7·8120	·247	·375	− 1·596	− 1·257	− ·739	·925	1·322	·721	6·033
Condylar Lengths Index	93·98	10·3082	·012	·904	− 1·278	− ·949	− 1·240	·312	1·622	·618	·526
Bicondylar Ratio ...	18·96	3·8088	− 1·552	− 1·224	1·612	·536	·851	− ·410	·483	− ·291	− 2·156
Band-radial Index ...	99·25	8·8276	− ·164	− ·493	− ·051	− ·227	− 1·875	1·445	− ·074	1·439	− 3·212
Condylar Trochant. Index	13·88	2·4644	− 1·818	− 1·209	·353	·028	·576	·130	1·631	·312	− ·398
Distal Articulation Ratio	16·63	3·3686	− 1·449	− 1·286	1·713	·570	·941	− ·187	− ·039	− ·261	− 2·117
Distal Articulation Index	88·09	4·4593	·361	− ·491	·226	− ·883	1·168	1·235	− 1·948	·327	·081
Rotular Ratio	6·27	1·2889	− ·442	·256	·877	·722	1·575	− ·753	− 1·800	− ·403	2·273
Rotular Index	37·90	7·6184	1·366	1·274	− ·656	·112	·538	− ·657	− 1·825	− ·151	7·727
Diaphysial Rotular Ratio	7·34	1·7750	− ·501	− ·417	·823	·710	1·893	− ·699	− 1·487	− ·332	1·837
Mean Indicial Deviation	—		·791	·993	·919	·599	1·140	·675	1·223	·486	2·636
Mean Indicial Deviation paying attention to sign	...		− ·328	− ·109	+ ·169	·053	+ ·307	+ ·112	+ ·176	+ ·165	+ ·883

Diagram D.



Indices of Distal Epiphysis. Scale 5 mm. = ·1.

the Gorilla, while exceptionally *Hylobates* is more primitive than *Dryopithecus rhenanus* and Neanderthal Man.

Diagram D (p. 497), drawn up in the same manner as before, illustrates all these points effectively, while we note that for the distal epiphysis the development of Recent Man is on the supergorilloid and not the superhuman side of the perfect Simio-human axis. This position is undoubted, although exceptional, and somewhat disconcerting from the standpoint of nomenclature.

The following are the relative orders for the mean interspecial differences of the characters of the distal epiphysis:

SUBTABLE XV. *Mean Interspecial Differences, Men and Apes.*

Pithecanthropus erectus		Neanderthal Man		Recent Man	
Recent Man	·302	Recent Man	1·193	*Pithecanthropus erectus*	·302
Hylobates	1·035	*Pithecanthropus erectus*	1·195	*Hylobates*	·902
Dryopithecus rhenanus	1·128	Chimpanzee	1·529	*Dryopithecus rhenanus*	·903
Neanderthal Man	1·195	*Dryopithecus rhenanus*	1·556	Chimpanzee	1·079
Chimpanzee	1·269	*Hylobates*	1·751	Neanderthal Man	1·193
Gorilla	1·391	Gorilla	1·843	Gorilla	1·266
Orang	1·555	Orang	2·136	Orang	1·597
Tarsius spectrum	2·928	*Tarsius spectrum*	3·467	*Tarsius spectrum*	2·746

Now this subtable shows remarkable relations. While in the characters of the bust both Primogenial and Recent Man are further removed from *Hylobates* and the Gorilla, in the characters of the distal epiphysis the Orang is most remote. The greatest resemblance in Recent Man is actually to *Hylobates* and *Dryopithecus*. Even the Chimpanzee comes before Neanderthal Man. Thus Recent Man is distinctly gibbon-like in the distal epiphysis, but it must be remembered that it is precisely in the characters of the distal epiphysis that Recent Man has travelled furthest from the simio-human mean. It is exactly the same with *Pithecanthropus*, it is in distal epiphysis closer to the Gibbon than to the Greater Anthropoids[1]. Only in the case of Neanderthal Man does the Chimpanzee come by its own again and displace the Gibbons. Clearly the Orang for the distal epiphysis has had a very individual evolution, which has carried it far from man as well as from the simio-human mean.

So far as we are aware no claim to a gibbon-like ancestor for man has been based on any close resemblance of the distal epiphysis in Recent Man and the Gibbon, but it is we think the one region of the femur upon which such a relationship could be based.

(5) *Relationships on the Basis of the combined forty Femoral Indices.*

As the different regions of the femur do not give wholly concordant results—an occurrence which might well be anticipated with divergent lines of evolution—we think it desirable to discuss the conclusions which flow from a consideration of the shape of the femur as a whole, *i.e.* when we pool our forty indicial characters.

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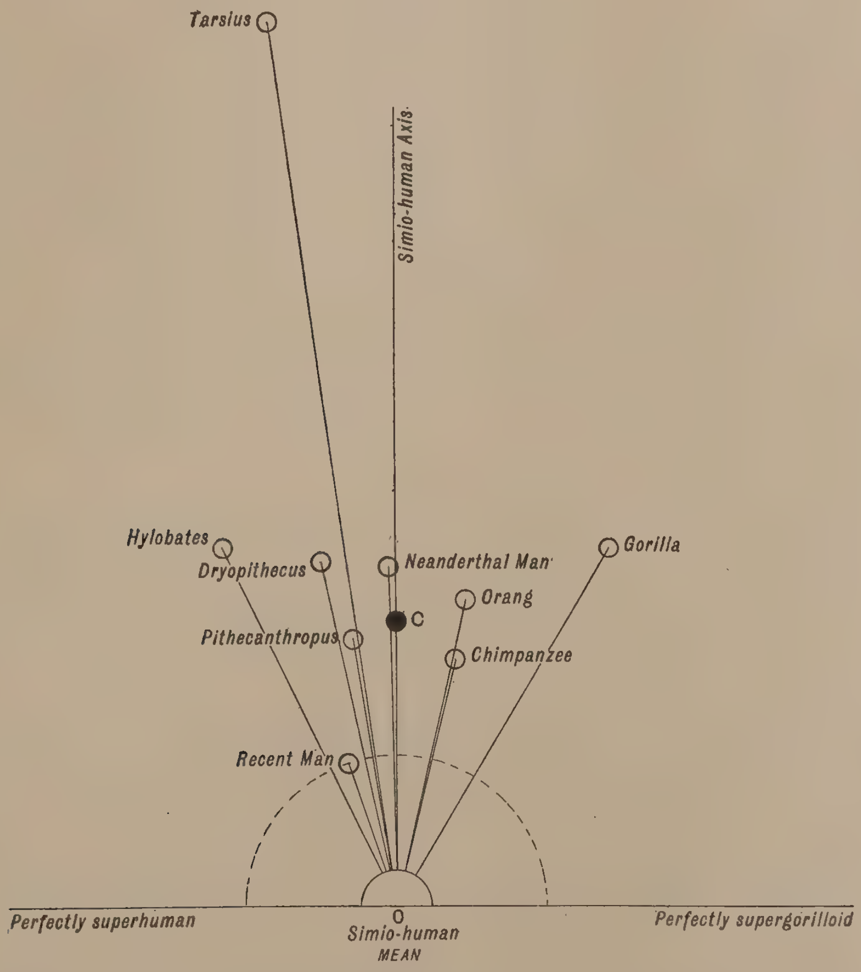
[1] It tends of course to confirm the result for Recent Man, but we can never lay very great stress on results for a single femur, knowing how femoral characters vary, and that in no case is *Pithecanthropus* like an individual gorilla quite outside the human range of variation. Added to this we have the great uncertainty of the determination of nearly every measurement in the case of the Trinil femur.

Subtable XVI. *Mean Indicial Deviations for forty Femoral Characters.*

	Gibbon	*Dryo-pithecus*	Gorilla	Chim-panzee	Orang-utan	*Pithecan-thropus*	Neander-thal Man	Recent Man	*Tarsius spectrum*
Mean Indicial Deviation ...	1·069	·946	1·112	·695	·858	·715	·914	·394	2·498
Mean Indicial Deviation paying attention to sign	− ·4816	− ·1984	+ ·5715	+ ·1622	+ ·1944	− ·1128	− ·0119	− ·1236	− ·3635
θ	− 26° 47′	− 12° 6′	+ 30° 55′	+ 13° 30′	+ 13° 6′	− 9° 5′	− 0° 45′	− 18° 17′	− 8° 22′

The order of approach to the perfect Simio-human femur would be measured by the smallness of the radius vector and the smallness of the angle from the vertical of the following diagram.

Diagram E.



General Diagram giving the results for forty femoral indices. C is the vector mean.
Scale 5 mm. = ·1.

Subtable XVII. *Order of Mean Indicial Deviations.*

Recent Man	·394
Chimpanzee	·695
Pithecanthropus erectus ...	·715
Orang-utan	·858
Neanderthal Man	·914
Dryopithecus rhenanus ...	·946
Hylobates	1·069
Gorilla	1·112
Tarsius spectrum	2·498

Now the results which flow from the above general order are of very great interest, and the reader must give to them the weight due to an analysis based on forty separate indices:

(i) Recent Man is by far the closest of any member of the group to the Simio-human mean.

(ii) The Gibbon and the Gorilla are furthest removed.

(iii) The Chimpanzee and the Orang are nearest of the anthropoids to the Simio-human mean. If we regard the fossil gibbon, *Dryopithecus*, as nearer by 100 points in the 1000 to that mean than the recent gibbon we might anticipate that the ancestors in like stages of the Chimpanzee and Orang would be about 50 per cent. and 100 per cent. respectively more divergent than Recent Man from the Simio-human mean.

Thus just as *Dryopithecus* draws in for both radius vector and angle on recent *Hylobates*, we should anticipate that the ancestors of Orang and Chimpanzee would draw in for both radius and angle on their modern representatives and so place themselves close to the perfect Simio-human axis, and so to speak within the region mapped out by a curve through the points occupied by Neanderthal Man, *Pithecanthropus* and Recent Man.

The conclusion seems forced upon us that:

(iv) The femur of the primitive Simio-human was probably more human than it has been given credit for. It was a human femur modified by a chimpanzee and to a less extent by an orang character. It was remote from the Recent Gibbon and the existing Gorilla, although naturally it would be somewhat nearer to their fossil ancestors.

This fundamental result appears to be absolutely in accord with the independent conclusion we were driven to by a consideration of the anomalies of the femur—they pointed in the direction of the Chimpanzee and not in that of a gibbon-like ancestor (see our pp. 479—485), still less in that of a gorilloid ancester.

We have given direction to our deviation from the Simio-human mean, by considering whether an individual in the group had excess or defect in the average of indices over the Simio-human mean. If we now take the centroid or mean of our *localised* points, it falls at the point marked C on the perfect Simio-human axis. It is somewhat in the direction of this localised mean, that we should anticipate the ancestors of Neanderthal Man, *Pithecanthropus erectus*, Orang and Chimpanzee closing in. This Simio-human centroid—to distinguish it from the purely numerical simio-human mean—is interpolated between Neanderthal Man and Recent Man, and is on the other side of *Pithecanthropus* to the Gibbons.

(v) *Final Problems.*

Two problems therefore suggest themselves, which may be discussed, if they cannot be answered on the basis of our present material and knowledge.

In the first place the femur of Recent Man may be described as "primitive" if by this we denote that it is quantitatively nearest of all to the simio-human mean. So far we are to a certain extent in agreement with Professor Wood-Jones, but this "primitiveness" is not that at any rate of the femur of *Tarsius*. Nor is it in the direction of the relative simplicity of the femur of the Gibbon; the primitiveness demands something of the robustness and complexity of the human and Chimpanzee femora.

But this is to be borne in mind:—if we go back to the primitive Simio-human we shall find that if his femur has not changed as much as some have anticipated from the human, his skull will certainly have changed to a far more simian type. Can it therefore be that the combination of the very simian skull cap of *Pithecanthropus* with the very human femur which has been associated with it fulfils the essential conditions suggested by our investigation of the Simio-human indices? In the course of this work we have come across no character of the Trinil femur which could not be considered as human, and what is more falling well within the range of individual variations of Recent Man. But what if all these characters are not only human, but prot-simio-human? The answer to this problem must not be lightly given. There have been two opposed schools of opinion with regard to the Trinil femur, one asserts that it is purely a human femur, and with this we agree—and the other finds reasons which convince its supporters, but which we fail to appreciate, for its being the femur of an ape—in particular of a gigantic gibbon. It would be a strange turning of the tables, if the former school had really been arguing in favour of a close relation between *Pithecanthropus* and the Prot-simio-human! Now we consider that in no case does the Trinil femur outrun the range of character variations which occur in human femora, but in every long series of human femora it is possible to note some that are more gibbon-like than the average and others which for want of a better word may be termed more gorilloid. The Trinil femur belongs to the former group, but it is not as far as we can discover more gibbon-like than many human femora. These gibbon-like variations would not be anything extraordinary in a recent human femur, but if the Trinil femur is to be taken as approximating to the primitive simio-human type we consider that they become far more improbable, *because we see strong arguments against a gibbon-like ancestor for the simio-human group. On the contrary we should expect the prot-simio-human femur to have human plus chimpanzee and not plus gibbon features.*

Such an ancestral line leads us to a muscular rather massive, bowed and fossed femur, and not to the straight, slender unfossed gibbon form. We are moving in the direction of the *Cercopithecidae* and the Lemuroids, and the Gibbon has specialised in a wholly different direction. That the Trinil femur is closer to *Hylobates* in the characters of its distal epiphysis than to *Dryopithecus* is not in its favour as a prot-simio-human femur; it is in our opinion directly against it[1]. We need to approach closer rather than to recede further from a link with chimpanzee characters. Granted a gibbon-like ancestor, we have to account for the appearance in the human femora of the marked robusticity, the considerable bowing, the increased obliquity, the hypotrochanteric fossa, and the third trochanter. Why have they disappeared in the Gibbon to reappear again in Man? We need a chimpanzee-like stage to link up our prot-simio-human with the like types among the lesser apes.

Hence although the strength of the human features of the Trinil femur—which has been so manifested in the course of our investigations in the last chapter—is not so markedly against the claims made for the Trinil femur as one school has considered, the very gibbon characters claimed for it by the opposite school, which to a moderate extent we admit to exist, appear to us to disqualify it as the femur of a forbear of Man. Its claim to that must be based entirely on its human attributes and not on its gibbon-like features.

Now this first problem raises indeed our second problem. If the Trinil femur represents the true femur of a Prot-simio-human, then we think it would be necessary to accept the position of a double origin of man. The transition from the Trinil femur to the femur of Recent Man could hardly have been made by way of the femora of Neanderthal type. We can scarcely suppose that man sunk after the Trinil stage to such a bowed pilasterless form, and then largely reverted to the Trinil type.

If the marked human pilaster did not owe its introduction to the later Cromagnon type, but a pilaster existed even in the Prot-simio-human, we look in vain for its source. Only the slightest traces of it can be found in the Gibbon and it exists in no marked form in the lesser apes. If we stick to the solid ground of the first *marked* appearance of the pilaster in the Cromagnon type, then its pilasterless predecessor may be easily predicted to have been a robust and bowed, because pilasterless form; a form also which would have more marked frequency of the anomalies of the human femur—and the Neanderthal type suits closely the necessities of the case. But the Neanderthal femur requires behind it not another Recent Human femur, not a gibbon-like femur, not even a *Dryopithecus* femur—unless it were largely strengthened by chimpanzee-like features—but what, for a better descriptive name, we may term a troglodytic femur.

We find it very difficult to place a Cromagnon-like type in the direct line of man's ancestry (in order to introduce the essential pilaster) and at the same time not to demand an extremely robust, if pilasterless, femur behind Cromagnon, *i.e.* a femur of practically Neanderthal type. Such is our reason for placing the Neanderthal femur at least close to the main human line, and with this as linkage a return to such a recent man type as the Trinil femur seems unreasonable. Back of the Neanderthal type the robusticity has to be partly lost as we approach the Prot-simio-human, and we can see something of this disappearance in the femur of the Chimpanzee. Less the pilaster this prot-simio-human femur was possibly more recent manlike in its indices than its successors, the Neanderthal and Cromagnon types, to which Recent Man is indebted for robusticity and pilaster through transitional exaggerated types. We do not state this as dogma, but it appears to us a more reasonable hypothesis *as far as evidence based on a single bone is concerned* than any theory which links up Man with gibbon-like forms relatively recently, and places the link with the greater *Simiinae* at a far greater distance. If such an arrangement be correct we have to suppose that features which are frequent anomalies in the recent human femur and almost special characters of *Homo neanderthalensis*, and which both share with the greater anthropoids, were independently developed in two distant primate lines. Such a character as the hypotrochanteric fossa in Recent Man exhibits all the signs of a disappearing phenomenon becoming less and less frequent since palaeolithic times. It is more reasonable to suppose it as a vestige of what was once a generic character—even as the lateral protrusion of the anterior face in modern man is a vestige of a lemuroid generic character—than to suggest its independent development in two or even more simio-human lines proceeding from a gibbon-like origin[1].

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[1] The reader should not forget meanwhile the essentially important point also that it is more than three times closer to Recent Man than to *Hylobates*!

Venturesome as it may appear to many for the biometrician to enter this field we cannot refrain from a strong opinion that gibbon-like forms lie off the main line of simio-human ancestry, and that accordingly the old pedigrees of the Primates—such as that of Haeckel—and the more modern ones—such as those of Dubois and Pilgrim—need serious modification when judged by the metrical relationships of the femora of the Primates.

We put forward as a working hypothesis that the prot-simio-human femur was not a simple, straight, slender femur—a hylobatic femur developed for lightness and agility—but a troglodyte femur, robust, fossed for muscular attachments, and bowed, but without pilaster, in fact a much more human femur—modified probably in the chimpanzee direction—but built for strength rather than agility. If the branch-point of the Gibbon be definitely later than this Prot-simio-human, then its evolution will be found to be from the robust to the less robust. The Eppelsheimer femur, more robust than those of recent gibbons, is a simplification of a still more robust, and a more bowed femur.

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[1] This criticism, of course, applies to Pilgrim's suggested Evolution of Man and the Anthropoids (Bibl. 118 *bis*, Chart and text). That scheme is largely based on a study of the teeth, often individual teeth, and portions of the jaws. We venture to think the certainty of teeth inferences will be somewhat weakened when longer studies have been published on the dental variations existing within a single species. We should also know better where we stand, if a fossil femur had been found, which could be definitely associated with any of the now very numerous named fossil primates known at present only by teeth or jaw fragments; there are probably more than a dozen such fossil primates. The one femur of the kind which exists is the Eppelsheimer femur. Its indices place it undoubtedly in the gibbon-like class. Yet in Bronn's *Thier.-Reich* (Bd. VI. Abth. V. Bd. I. S. 594) it is spoken of as *Dryopithecus*, and quite recently Abel (Bibl. 87 *ter*) terms it *Dryopithecus rhenanus*, and Bumüller (Bibl. 81) also classifies it in the same manner. If *Dryopithecus* had a femur of this character and the propliopithecine ancestors of man a similar one then the appearance of common characters in Recent Man, Neanderthal Man, Chimpanzee, Gorilla and Orang, cut off by such ancestry from each other and from the *Cercopithecidae*, is a stiff proposition. Even if we assume the Eppelsheimer femur to be pliohylobatic, and the *Dryopithecus* femur to have had a more troglodyte character, then the femur of Recent Man for the one part, the femur of Neanderthal Man for the second part, and the femur of *Dryopithecus* as ancestor of the greater anthropoids for the third part, will still be separated by Pilgrim's scheme from kindred forms in the *Cercopithecidae* by a gibbon-like ancestry possessing little or nothing of the troglodyte features of great robusticity, marked fossing and exaggerated bowing.

We admit that this unorthodox view is tentative and will be unsympathetic as reinstating a more troglodyte ancestry for man[1]. It accounts, however, to some extent for the suggestive "primitiveness" of several human characters. The crucial test will come not with the discovery of fossil ancestors of the Gibbon, but with that of fossil ancestors of the troglodytes; these, on our hypothesis, should be more human than we have hitherto supposed—a lighter phase of the Neanderthal femur—which would in some respects make it more recent man-like, but also would probably draw it towards the Chimpanzee. In one respect, that of pithecoid index, it might turn out to be more orangoid than chimpanzee-like. Until the discovery of fossil troglodyte members of the simio-human group has been made we can but see how far our views are in accord with a wider if less intensive[2] study of the femora of the whole range of primates. This we propose to undertake on the basis of the measurements published in this section in an Appendix to be issued as Part III of the text of this monograph.

It will of course be objected, and the criticism is justified, that all our conclusions have been based on a study of a single bone. But then the chief aim of this monograph has been and will continue to be the discovery of how much can be ascertained from the intensive study of single bones. As far as man is concerned the measurements have been taken, tabled and reduced for a variety of other long bones, and it is solely the very limited powers of computation, analysis, and publication which are and have been at the service of the Biometric Laboratory that have delayed through long years even the appearance of Parts I and II of this work. Only with the publication of the sections on the Humerus or the Tibia will it be possible for the first time to ascertain how far conclusions based on a single bone may be safely extended to the whole organism. At any rate up to the present we believe that attention possibly has been too much concentrated for evolutionary purposes on the primate cranium, or even on the mandible alone. It is from this standpoint desirable to discover the extent to which other bones of the skeleton confirm or contradict the conclusions drawn from the skull or the teeth.

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[1] We fear that what Professor Wood-Jones terms the "stain" on British science will not be washed away by any Tarsian fluid hypothesis. Our Prot-simio-human was troglodytic, an ape if a more refined ape than the gorilla!

[2] Less intensive in that for Recent Man we have measured many hundred femora, while in the case of the other primates we must perforce content ourselves with the few femora we have been able to measure of each species.

APPENDIX I

CORRELATION OF THE FEMORAL CHARACTERS IN MAN

So few exact determinations have been made of the correlation between femoral characters that we propose to cite in this appendix certain comparative values.

(*a*) Our first series is due to Tamagnini and de Campos whose memoir on the Portuguese femur[1] appeared after our chapter on correlation was printed off and accordingly could not then we regret to say be used for comparative purposes. It is the only memoir we are acquainted with which applies modern statistical methods to the study of the femur, and the authors are to be congratulated on thus breaking away from the old anatomical school of anthropologists. Where possible we give our own values for comparison. Except in the case of Bicondylar Width with Diameter of Head, where the numbers are ♂ 264, ♀ 250, the Portuguese authors appear to have worked with 134 male and 126 female femora. In the case of correlation of Collar

Character Pair	Portuguese		17th century Londoners	
	♂	♀	♂	♀
Excess of Maximum over Oblique Length and Obliquity	0·70 ± 0·03	0·83 ± 0·02	—	—
Excess of Maximum over Oblique Length and Collar Angle	0·08 ± 0·06	– 0·04 ± 0·06	—	—
Excess of Maximum over Oblique Length and Bust Length	– 0·06 ± 0·06	?	—	—
Oblique Length and Diameter of Head ...	0·09 ± 0·06	0·07 ± 0·06	·561 ± ·033*	·408 ± ·046*
„ „ „ Pilastric Transverse ...	0·03 ± 0·06	0·06 ± 0·06	·331 ± ·040‡	·115 ± ·050‡
„ „ „ Pilastric Ant. Post. Diam.	0·07 ± 0·06	0·10 ± 0·06	·331 ± ·040‡	·353 ± ·044‡
„ „ „ Distal Articulation Width	0·08 ± 0·06	0·05 ± 0·06	·556 ± ·037*†	·434 ± ·053*†
„ „ „ Index of Platymery ...	0·02 ± 0·06	0·01 ± 0·06	– ·007 ± ·045*	+ ·121 ± ·054*
„ „ „ Length of Bust	0·11 ± 0·06	0·08 ± 0·06	·262 ± ·044	·058 ± ·054
„ „ „ Collar Angle	0·02	? ♂ + ♀	·256 ± ·043	·211 ± ·050
„ „ „ Obliquity	– 0·01 ± 0·06	– 0·02 ± 0·06	– ·092 ± ·045	– ·047 ± ·052
Collar Angle and Obliquity	– 0·06 ± 0·06	– 0·13 ± 0·06	– ·244 ± ·044	– ·194 ± ·052
Length of Bust and Obliquity	– 0·01 ± 0·06	0·04 ± 0·06	—	—
„ „ „ „ Collar Angle	0·03 ± 0·06	0·08 ± 0·06	– ·222 ± ·043	– ·257 ± ·048
„ „ „ „ Distal Articulation Width	0·43 ± 0·05	0·52 ± 0·04	·356 ± ·047	·321 ± ·050
„ „ „ „ Diameter of Head ...	0·48 ± 0·04	0·51 ± 0·04	·354 ± ·042	·284 ± ·050
Distal Articulation Width and Diameter of Head	0·63 ± 0·03	0·63 ± 0·03	·760 ± ·023	·619 ± ·043
Angle of Torsion and Platymeric Index ...	0·05 ± 0·06	– 0·02 ± 0·06	– ·082 ± ·047	– ·006 ± ·054
Pilastric Ant. Post. and Transverse Diameter...	0·45 ± 0·05	0·45 ± 0·05	·285 ± ·040	·271 ± ·045

* Correlations for maximum instead of oblique length.
† Correlations for bicondylar width not distal articulation width.
‡ Correlations with shaft length and not oblique length.

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[1] Bibl. 118.

Angle and Length of Femur the value only is given without statement as to sex or number. Their "Length of Neck" finds its nearest equivalent in our Capito-collar Axis or Bust Length but is otherwise determined. We regret to say that we cannot accept the values Tamagnini and de Campos give for the correlations of size of femur with its transverse dimensions. We obtain much more substantial values, and these seem in accordance with the mere appreciative experience that *on the whole* larger or longer femora have greater transverse sections. We are also disinclined, especially in view of our own results, to accept the view that there is no sensible *negative* relation between collar angle and length of bust. Is it possible that in these cases some error has crept into the calculations based upon what was probably a novel mathematical procedure to the computers? We cannot test these results ourselves as the individual measurements are not provided by the authors. We cannot blame the authors for the non-publication of the correlation-tables; that may be in their case as in ours one of the economic effects of the war, but the complete absence of the raw data although it receives some sanction from frequent French practice is a grave disadvantage when it is needful to check or extend conclusions.

(*b*) Our second series of correlations has been deduced by us with the aid of a somewhat novel procedure from data given by Antony and Rivet in their memoir[1] often cited in our pages upon the prehistoric Indian femora of Paltacalo. These authors deal with a small series of about 69 ♂ and 52 ♀ femora. They divide their material up into three approximately equal groups according to one character[2] and find for each of these groups the mean value of the second. They then judge from the relative value of these three means whether there is any association, occasionally asserting it to exist when the three means do not run all in one sense. There are three obvious criticisms: (*a*) the authors' numbers—which may for certain characters not exceed 32—are very sparse for such a rough procedure, (*b*) the method does not provide, even if it were justified by size of categories, any quantitative measure of association, and (*c*) if any three numbers be taken *at random*, say m_1, m_2, m_3 in ascending order to represent the means of the three categories, then we can make six arrangements of them, namely:

$$\begin{array}{cccccc}
(1) & (2) & (3) & (4) & (5) & (6) \\
\begin{matrix} m_1 \\ m_2 \\ m_3 \end{matrix} &
\begin{matrix} m_3 \\ m_2 \\ m_1 \end{matrix} &
\begin{matrix} m_1 \\ \left\{\begin{matrix} m_3 \\ m_2 \end{matrix}\right. \end{matrix} &
\begin{matrix} \left\{\begin{matrix} m_2 \\ m_1 \end{matrix}\right. \\ m_3 \end{matrix} &
\begin{matrix} \left\{\begin{matrix} m_2 \\ m_3 \end{matrix}\right. \\ m_1 \end{matrix} &
\begin{matrix} m_3 \\ \left\{\begin{matrix} m_1 \\ m_2 \end{matrix}\right. \end{matrix}
\end{array}$$

The first two (1) and (2) give "clearly" positive and negative correlation. The third and fourth (3) and (4) positive correlation, and (5) and (6) negative correlation, if the examiner actually puts in or visualises the brackets.

Omitting the associations with bowing Antony and Rivet give 104 tables of this kind, of which 53 show positive, 50 negative and one zero correlation[3]. They have no quantitative standard of which are significant and which insignificant. Some they say mean nothing and others they accept as important, although very often the two sexes run in opposite directions[1]. Now the probable error of a coefficient of correlation based upon the numbers used by the present authors is of the order ·08 to ·10. Hence the material they provide is inadequate to determine whether there is correlation or not, unless the correlation coefficient exceeds at least ·20. Can we then obtain approximate values for the correlation? Let $\tilde{y}_1$ and $\tilde{y}_3$ be the means of the high and low groups corresponding to the mean abscissae $\tilde{x}_1$ and $\tilde{x}_3$ of those groups. Then, assuming the regression linear, $(\tilde{y}_1 - \tilde{y}_3)/(\tilde{x}_1 - \tilde{x}_3) =$ the regression coefficient, $= R$ say. It follows therefore that the correlation will be

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[1] Bibl. 98 *bis*.

[2] *i.e.* into high, medium and low value classes.

[3] The proportions are of course strikingly close to those that would be obtained by random selection in the case of uncorrelated material.

$$r = R\sigma_x/\sigma_y\,.$$

Hence if we can find σ_x and σ_y since R is known we have an approximate value of r. Unfortunately the material for the determination of σ_x and σ_y is often very slender; the frequency distributions of the characters are not always given, and when provided are often arranged in sadly few groups. However we have ventured on 42 correlation coefficients which are given below, our own being added when known.

Character Pair	Paltacalo Indians		17th century Londoners	
	♂	♀	♂	♀
Collar Angle and Oblique Length... ...	+ ·150*	− ·140*	+ ·256 ± ·043	+ ·211 ± ·050
,, ,, ,, Platymeric Index ...	+ ·082*	+ ·144*	+ ·366 ± ·038	+ ·357 ± ·044
,, ,, ,, Pilastric Index	+ ·016*	− ·164*	—	—
,, ,, ,, Torsional Angle ...	+ ·031*	+ ·107*	—	—
,, ,, ,, Ellipticity of Neck ...	+ ·015*	+ ·260	+ ·057 ± ·044	+ ·284 ± ·045
,, ,, ,, Length of Bust... ...	− ·050*	− ·392	− ·222 ± ·043	− ·257 ± ·048
Platymeric Index and Oblique Length ...	+ ·332	− ·469	− ·007 ± ·045	+ ·121 ± ·054
,, ,, ,, Pilastric Index ...	+ ·518	+ ·359	+ ·503 ± ·032	+ ·396 ± ·042
,, ,, ,, Torsional Angle ...	+ ·098*	− ·413	− ·082 ± ·047	− ·006 ± ·054
,, ,, ,, Ellipticity of Neck	− ·007*	− ·008*	+ ·010 ± ·044	+ ·154 ± ·051
,, ,, ,, Length of Bust ...	+ ·054*	− ·011*	—	—
Pilastric Index and Oblique Length ...	− ·021*	+ ·261	+ ·153 ± ·044	+ ·202 ± ·049
,, ,, ,, Torsional Angle ...	+ ·358	+ ·297	− ·096 ± ·046	+ ·055 ± ·054
,, ,, ,, Ellipticity of Neck ...	+ ·126*	− ·191*	—	—
,, ,, ,, Length of Bust ...	− ·013*	+ ·256	—	—
Torsional Angle and Oblique Length ...	− ·130*	+ ·471	− ·047 ± ·047	+ ·100 ± ·053
,, ,, ,, Ellipticity of Neck ...	+ ·072*	− ·066*	—	—
,, ,, ,, Length of Bust ...	+ ·013*	+ ·112*	− ·200 ± ·045	− ·247 ± ·052
Ellipticity of Neck and Oblique Length ...	+ ·037*	− ·174*	—	—
,, ,, ,, ,, Length of Bust ...	+ ·079*	− ·117*	—	—
Length of Neck and Oblique Length ...	+ ·246	+ ·378	+ ·262 ± ·044	+ ·058 ± ·054

In all the cases marked with an asterisk the data are insufficient to determine whether there is or is not correlation let alone its sign or magnitude. In the bulk of cases therefore Antony and Rivet should not have expressed any other opinion than "data inadequate to determine whether or not association exists." In cases where comparison is possible we may note good accordance in Collar Angle with Ellipticity of Neck, the emphasis of female over male being repeated. In Collar Angle and Length of Bust the negative sign is confirmed. We cannot substantiate the high negative value of the correlation between Platymeric Index and Oblique Length for female femora and think that Antony and Rivet's 13 femora of the low length class possibly contained certain anomalous bones of accentuated platymeric character. The evil of such small numbers is that one or two anomalous bones may upset the complete system of the series. This remark applies equally to these authors' result for the correlation of platymery and torsion in the case of the female bones. All their torsional results are indeed difficult to accept under the circumstances. It is not only that the material is also inadequate, but the method of presentation is inadequate having regard to modern statistical requirements. We have introduced this table, so that we may in the first place not be charged with overlooking other people's work, but in the second place more especially because we want it definitely recognised that it will only be possible to distinguish racial and sexual differences in correlation where series are available which amount to several hundred at least for each sex. Until we know what is the order of racial and sexual variations in correlation it is simply impossible to assert from small series that certain associations hold in femoral characters; to affirm such relations is merely throwing back anthropometry, in particular osteology, into the slough in which it floundered during the last century.

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[1] The sex proportions of the correlations are ♂ : 33 +, 19 − and no zero; ♀ : 20 +, 31 − and 1 zero. Thus the females have more negative and the males more positive associations.

APPENDIX II

FEMORA OF FOSSIL LEMUROIDS FROM MIDDLE EOCENE, BRIDGER FORMATION, U.S.A.

I owe to the kindness of the authorities of the American Museum of Natural History casts of the long bones of the recently found fossil lemuroids. The two of which femora have survived have been named *Notharctus osborni* and *Notharctus tenebrosus* (Leidy). The discovery of these fossil lemuroids taken in conjunction with the earlier finding of European fossil lemuroids[1] completes Wallace's argument that the hypothesis of Lemuria—a continent once linking up Borneo with Madagascar—is idle, for the Lemuroids would ultimately be found to have been spread not only through the old but the new world. The femora are in fairly good condition, although obviously much labour and care have been spent in piecing them together. Thus the measurements given in the accompanying table are to some extent open to question, and not too much stress must be laid on such characters as the torsion and bowing. A full discussion on the relationships of these lemuroids is at present preparing for press, and in the able hands of Dr Gregory. Here we content ourselves with a few remarks suggested by a comparison of the present system of femoral characters with those recorded in the last chapter of our monograph.

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[1] H. Filhol: "Mammifères fossiles d'Europe et d'Amérique," *Annales des sciences géologiques*, T. 14, pp. 1—51. Paris, 1883.

TABLE I. *Femora of Fossil Lemuroids from Middle Eocene, U.S.A.*

	Characters (from casts)	*Notharctus osborni* (R.)	*Notharctus tenebrosus*, Leidy (R.)
Major Lengths	Maximum Length	123·3	139·5
	Trochanteric Length	121·5	138·6
	Maximum Trochanteric Length	121·9	138·9
	Oblique Length	123·2	139·4
	Trochanteric Oblique Length	121·2	138·5
	Capito-trochlear Length	121·2	137·8
	Diaphysial Length	103·2	121·0
	Length of Shaft	114·7	127·8
Bust	Vert. Diameter of Head	10·2	12·8
	Horiz. Diameter of Head	10·4	12·7
	Minimum Horiz. Diameter of Neck	6·4	7·8
	Minimum Vert. Diameter of Neck	8·6	10·0
	Capito-collar Length	13·4	20·2
	Length of Neck	8·3	13·8
Shaft	Proximal Breadth	20·9	24·0
	Platymeric Ant. Post. Diameter	7·7	7·6
	Platymeric Transverse Diameter	7·8	9·5
	Pilastric Ant. Post. Diameter	8·6	8·0
	Pilastric Transverse Diameter	8·7	9·1
	Popliteal Length	?	?
	Popliteal Width	8·0	10·6
	Popliteal Direct Ant. Post. Diam.	7·2	7·8
	Popliteal Oblique Ant. Post. Diam.	7·6	8·0
	Diaphysial Chord	70·9	83·5
	Diaphysial Subtense	0	2·0
	Prox. Segment Diaphysial Chord	?	56·4
Condyles	Bicondylar Width	16·7	19·7
	Max. Length Ext. Condyle	18·2	20·1
	Max. Length Int. Condyle	16·0	18·3
	Oblique Length Ext. Condyle	17·0	19·6
	Oblique Length Int. Condyle	15·6	18·2
	Ext. Condyle Horiz. Band-radius	5·1	6·3 ?
	Ext. Condyle Vert. Band-radius	5·1	6·4 ?
	Height of Patellar Surface	12·0	11·9
	Breadth of Distal Articulation	14·6	18·0
Angles	Midtrochlear Angle	4°·8	7°·4
	Angle at Centre of Head	46°·0	56°·4
	Collar Angle	129°·0	116°·2
	Torsion of Shaft	19°·0	29°·3
	Torsional Angle	29°·9	22°·8
	Retorsional Angle	−10°·9	+6°·5
	Obliquity	2°·0	1°·0
	Pseudo-Obliquity	2°·3	2°·15

	Indices (from casts)	*Notharctus osborni* (R.)	*Notharctus tenebrosus*, Leidy (R.)
General Indices	Oblique Direct Lengths Index	99·92	99·93
	Oblique Direct Troch. Lengths Index	99·75	99·93
	Proximal Breadth Ratio	17·20	17·32
	Distal Breadth Ratio	13·74	14·21
	Pithecoid Index	98·38	99·35
	Robusticity of Femur	14·04	12·27
Bust Indices	Robusticity of Head	16·72	18·29
	Ellipticity of Head	98·07	100·79
	Ellipticity of Neck	74·42	78·00
	Secondary Index of Neck	61·54	61·42
	Lemotic Index	6·74	9·90
	Head Bust Ratio	76·12	63·37
	Primary Bust Ratio	10·87	14·48
	Secondary Bust Ratio	10·88	14·49
	Bust Shaft Index	11·68	15·81
	Capital Ratio	8·27	9·18
	Capito-bicondylar Ratio	61·08	64·97
	Epiphysial Ratio	80·24	102·53
Shaft Indices	Platymeric Index	98·72	80·00
	Pilastric Index	98·85	87·91
	Popliteal Index	90·00	73·58
	Index of Popliteal Skewness	94·74	97·50
	Popliteal Pyramidal Index	?	?
	Soffit Index	47·90	53·81
	Index of Gracility (Upper)	111·54	95·79
	Index of Gracility (Lower)	108·75	85·85
	Index of Transverse Slenderness	7·6	8·6
	Index of Sagittal Slenderness	7·5	6·3
	Index of Proximal Taper	89·53	95·00
	Index of Distal Taper	83·72	97·50
	Popliteal Shaft Index	?	?
	Primary Index of Bowing	0	2·40
	Secondary Index of Bowing	?	67·54
Condylar Indices	Condylar Index	108·98	102·03
	Condylar Lengths Index	113·75	109·84
	Bicondylar Ratio	13·54	14·12
	Band-radial Index	100·00	98·44 ?
	Condylar Trochanteric Index	14·98	14·42
	Distal Articulation Ratio	11·84	12·90
	Distal Articulation Index	87·43	91·37
	Rotular Ratio	9·73	8·53
	Rotular Index	82·19	66·11
	Diaphysial Rotular Ratio	11·63	9·83

REMARKS. *Notharctus osborni*, Granger and Gregory (A. M. of N. H. 11474), Bridger formation, Bridger Basin (Horizon B), Wyoming, U.S.A. Head, with very slight evidence of *fovea*, slightly above great trochanter. Lateral protrusion with ridge form of 3rd trochanter. Very little anterior flattening, 2nd and 3rd trochanters roughly balance from posterior aspect, where the flattening is subtrochanteric. No pilaster. Marked posterior fossa but on mesial border of posterior face. Ill-defined popliteal surface without apex, flat to concave. No sensible bowing, but difficult to determine, of slight value as bone has been pieced together from fragments. Head fairly well defined but with extension on to top and posterior face of neck, no marked cut-away. Top of neck flat and broad. Patellar surface *m.r.*, of moderate length and with short tongue. Axis of shaft cuts neck at basis of head. Plane perpendicular to standard plane touching mesial epicondyle and top of 2nd trochanter only just grazes head. *Notharctus tenebrosus*, Leidy (A. M. of N. H. 1727), Bridger formation, Bridger Basin (Horizon B), Wyoming, U.S.A. Head with no sign of *fovea* and with great trochanter very nearly same level. Lateral protrusion and 3rd trochanter more massive than in *N. osborni.* Very little anterior flattening, posterior is below both 2nd and 3rd trochanters. No pilaster, no identifiable posterior fossa. Popliteal surface, flat, without apex and ill-defined. Slight positive bowing, but in present state not easy to measure. Two rather well-marked ridges appear to connect popliteal area with lateral upper border of mesial condyle and mesial upper border of lateral condyle. There are *cavities* to mesial and lateral sides of these ridges, where the two heads of *gastrocnemius* would usually be inserted. Head rather poorly defined, but probably damaged; extension on to top and posterior face of neck. ? a posterior cut-away or damage. Top of neck broad. Patellar surface *b.r.* to *m.r.*, moderate to short in length and but small signs of tongue. Axis of shaft passes through tip of great trochanter. Plane perpendicular to standard plane and touching mesial epicondyle and tip of 2nd trochanter intersects neck and base of head.

If we neglect absolute size and confine our attention to indices then a comparison of the mean values in Table III of the last chapter certainly suggests that *Notharctus osborni* corresponds most closely to the true Lemurs. In a number of respects *Notharctus tenebrosus* has a femur closer to that of *Chiromys* than to that of the true Lemurs. But both femora combine features which no longer appear common to recent lemuroids. Thus a very noteworthy feature of *Notharctus osborni* is that the mesial epicondyle, the tip of the lesser trochanter and the head can practically all be touched by one and the same plane drawn perpendicular to the standard vertical plane. Now this is a characteristic approximated to in the *Lorisinae* (*Potto, Loris gracilis* and *Nycticebus javanicus*); it is further approached in *Tarsius,* and occasionally in the *Galaginae.* We have no approach to it in our experience of the *Lemurinae* or *Indrisinae.* It is not in the least characteristic of *Notharctus tenebrosus.* In this respect *Notharctus osborni* resembles rather what we have termed the Tarsiidean than the Lemurine group of Lemuroids. It suggests therefore a transition form from the earlier lemuroids to the true lemurs. On the other hand in a rough way *Notharctus tenebrosus* links up the Aye-Aye and the true lemurs. Taking the above referred to relation of linearity in epicondyle, tip of second trochanter and head as a very marked differential of lemuroid genera, we are by no means certain that it would not be advisable to place the two fossils in separate genera. On the other hand the insignificance of the third trochanter in the *Lorisinae* is a feature which is not shared by *Notharctus osborni.* The third trochanter of the latter is a ridge form, which is lemurine, while that of *Notharctus tenebrosus* approaches more the nipple shape of the third trochanter of the Aye-Aye. Nor are these combinatory results improbable, if we consider that we are passing to forms closely allied to the ancestral types of recent lemuroids. A suggestive fact is that we have not been able to trace any approach to linearity of mesial epicondyle, second trochanter and head in the femora of any Old World monkeys, nor in the European fossil lemur *Adapis.* But approaches to this condition are certainly to be found in the *Cebidae,* and most notably in their more primitive forms such as the marmoset. If this be correct the American Eocene fossil lemuroid is closer to certain of the *Cebidae,* than the European Eocene lemuroid. The point is, perhaps, worthy of fuller study as the character is a marked one, and the criterion easily applied. If the tangent be drawn (on the projection of the femur on the standard vertical plane) from mesial epicondyle m, to touch the head in h, and the distance from the tip t of the trochanter minor to this tangent be tn, then the convenient index $100\, tn/mh$ may be formed and can for convenience be called the *Aspalacoid Index.* Table II on the following page gives the value of the Aspalacoid Index for the Primates

TABLE II. *The Aspalacoid Index for the Primates with Comparatives.*

Monotremes	*Ornithorhynchus*	−20·20	
	Echidna	4·15	
Marsupials	*Trichosurus vulpecula* (2)	3·16	
	Phascolomys ursinus	6·48	
	Macropus frenata	7·59	
Chiroptera[1]	*Pteropus medius* (Flying Fox)	−4·54	
	Pteropus sp. (Mollaques)	−6·18	
	Pteropus conspicillatus (2)	−7·02	
Edentates	*Dasypus sexcinctus*	0·00	
	Choloepus didactylus (3)	2·12	
	Tatusia peba	5·59	
	Tamandua tetradactyla	10·98	
Rodents	*Sciurus vulgaris* (2)	−0·00	
	Castor fiber	1·12	
	Hesperomys	1·27	
	Lepus cuniculus	3·66	
	Fiber zibethicus	6·49	
	Dasyprocta	10·00	
	Castor canadensis (2)	10·10	
Carnivores	*Felis domestica*	6·78	
	Canis familiaris (Pekinese Spaniel)	7·10	
	Lutra vulgaris (Common Otter)	12·50	
	Leo africanus (2)	12·73	
	Latax lutris (Sea Otter)	17·47	
Ungulates	*Equus caballus*	3·78	
	Ovis domesticus	6·62	
Insectivores	*Talpa europaea*	0·00	0·59
	Hylomys suillus dorsalis	0·40	
	Tupaia chrysura	0·00	
	Tupaia picta (2)	0·98	
	Tupaia minor (2)	1·57	
PRIMATES			
Fossil Lemuroids	*Notharctus osborni*	0·00	
	Adapis parisiensis	3·40	
	Notharctus tenebrosus (Leidy)	4·35	
Recent Lemuroids	*Tarsiidae* (3)	1·47	1·89
	Galaginae (6)	1·85	
	Chiromyrdae (2)	2·04	
	Lorisinae (6)	2·20	
PRIMATES (*cont.*)			
Recent Lemuroids	*Indrisinae* (8)	4·35	4·80
	Lemurinae (20)	5·25	
Cebidae	*Hapalinae* (18)	2·44	Mean 6·28
	Nyctipithecinae (8)	4·48	
	Brachyurus (2)	5·54	
	Pithecia (2)	5·92	
	Ateles (4)	6·71	
	Cebus (8)	6·71	
	Mycetes (2)	8·04	
	Lagothrix (2)	10·39	
Simiadae	*Macacus* (18)	5·04	Mean 5·78
	Cercocebus (4)	5·48	
	Cercopithecus (8)	5·62	
	Semnopithecus (10)	6·03	
	Cynocephalus (8)	6·72	
Anthropoidea, Hylobatinae	*Dryopithecus rhenanus*	6·39	
	Gibbon (3)	6·06	
Simiinae	Orang-utan (5)	9·63	Mean 11·68
	Chimpanzee (5)	10·94	
	Gorilla (11)	14·47	
	Pithecanthropus erectus	10·31	
Primogenial Man	Type A. La Ferrassie I	13·64	Mean 12·48
	La Chapelle-aux-Saints	13·01 ?	
	H. mousteriensis (*Hauseri*)	12·84	
	Spy	12·07	
	Neanderthal	10·84	
	Galley Hill	9·93 ?	
	Cromagnon Type (2)	10·58	
	Grimaldi Negroid Type (2)	10·48	
Recent Man	Andaman (1)	4·99	
	Bushmen (2)	8·22	
	Modern Europeans (15)	8·65	
	Fuegian (1)	10·90	
	Australians (2)	11·85	

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[1] We have examined a number of other species of Chiroptera and find the Aspalacoid Index always negative.

and a few comparatives which were available in the Biometric Laboratory at the time it was drawn up. This index measures the degree to which this mole-like femoral character appears in other species.

Examining the table we see that in the Tupaids the index is extremely low, and that this is also the case of the Tarsiidean group of the Lemuroids. The *Simiadae* and *Cebidae* advance sensibly, even on the true Lemurs, but the Old World monkeys have nothing like the range of values of the femora of the New World monkeys, the marmosets and *Lagothrix* being of the latter the outlying forms. The marmosets (2·44) approach nearest to the Tarsiidean group of the Lemuroids, and are for this index closer than any of the *Simiadae* to the fossil lemurs. The low values of the Aspalacoid Index in the fossil lemurs carry us distinctly a stage towards the Tarsiidean group and ultimately towards the Tupaids. Turning to the *Anthropoidea*, we note that the Recent Gibbon is not very widely differentiated from *Dryopithecus rhenanus* and both are fairly close to *Ateles*, and widely differentiated from the Greater Anthropoids. *Pithecanthropus erectus* is distinctly human[1] or if we please troglodyte, but not hylobatic. The *Simiinae* show a big advance on the *Simiadae* and this advance is continued in Primogenial man of the Neanderthal Type. With the Cromagnon Type comes a fall,—the Grimaldi Negroid Type having the same index as Cromagnon,—and this fall is continued in Recent Man of the European Type. Thus this new index—suggested by the striking characteristic which differentiates *Notharctus osborni* from *Notharctus tenebrosus*, Leidy—confirms much that we have already learnt from our detailed analysis of other femoral characters, especially the reversion of Recent Man from a greater to a less troglodyte character, *i.e.* he stands on the other side of the Greater Anthropoids to Neanderthal Man, and so somewhat closer to the Lesser Apes than Primogenial Man.

APPENDIX III

THE SESAMOID BONES OF THE KNEE-JOINT OF THE PRIMATES

One or more of at least seven sesamoid bones may be found associated with the knee-joint of the Primates. The *fabellae* occurring as anomalies in the *gastrocnemius* tendon of man are invariable in many genera of the Primates, and are recorded as "sesamoid bones" in the "Remarks" to Tables of Femoral measurements of the Primates in Part II of the *Atlas* to this monograph. But our investigations into the sesamoids of the knee-joint of the Primates have developed to such an extent, that we have thought it necessary to suppress this appendix and to publish an independent memoir on the subject.

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[1] The range of Europeans is about 6 to 11.

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II. TABLES OF MEASUREMENTS

Measurements of Femoral Characters of the Primates (Man, Anthropoids, Lesser Apes and Lemuroids).

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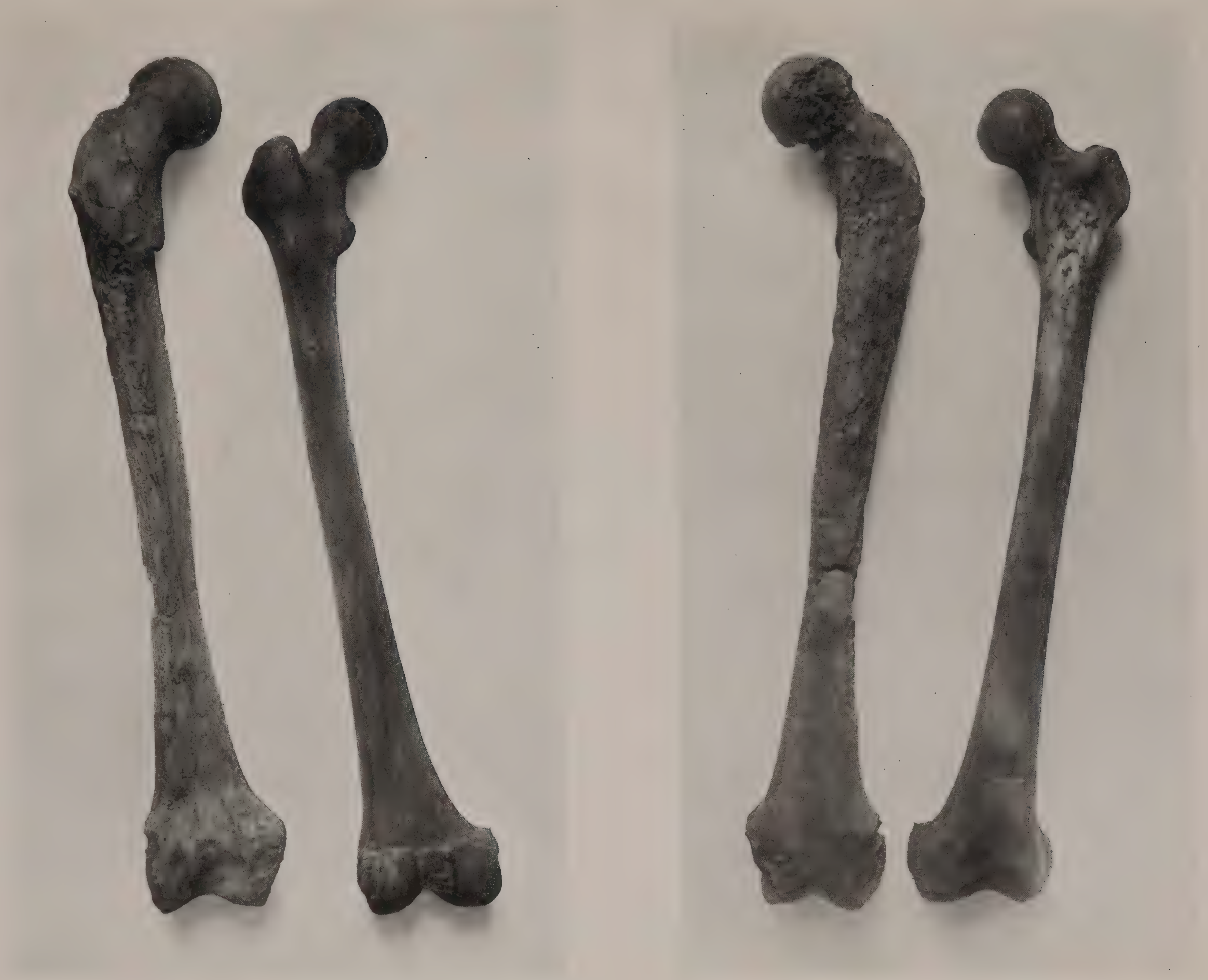
Table II. (Indices of the Shaft, Indices of the Distal Epiphysis, and Remarks on Descriptive Characters.)

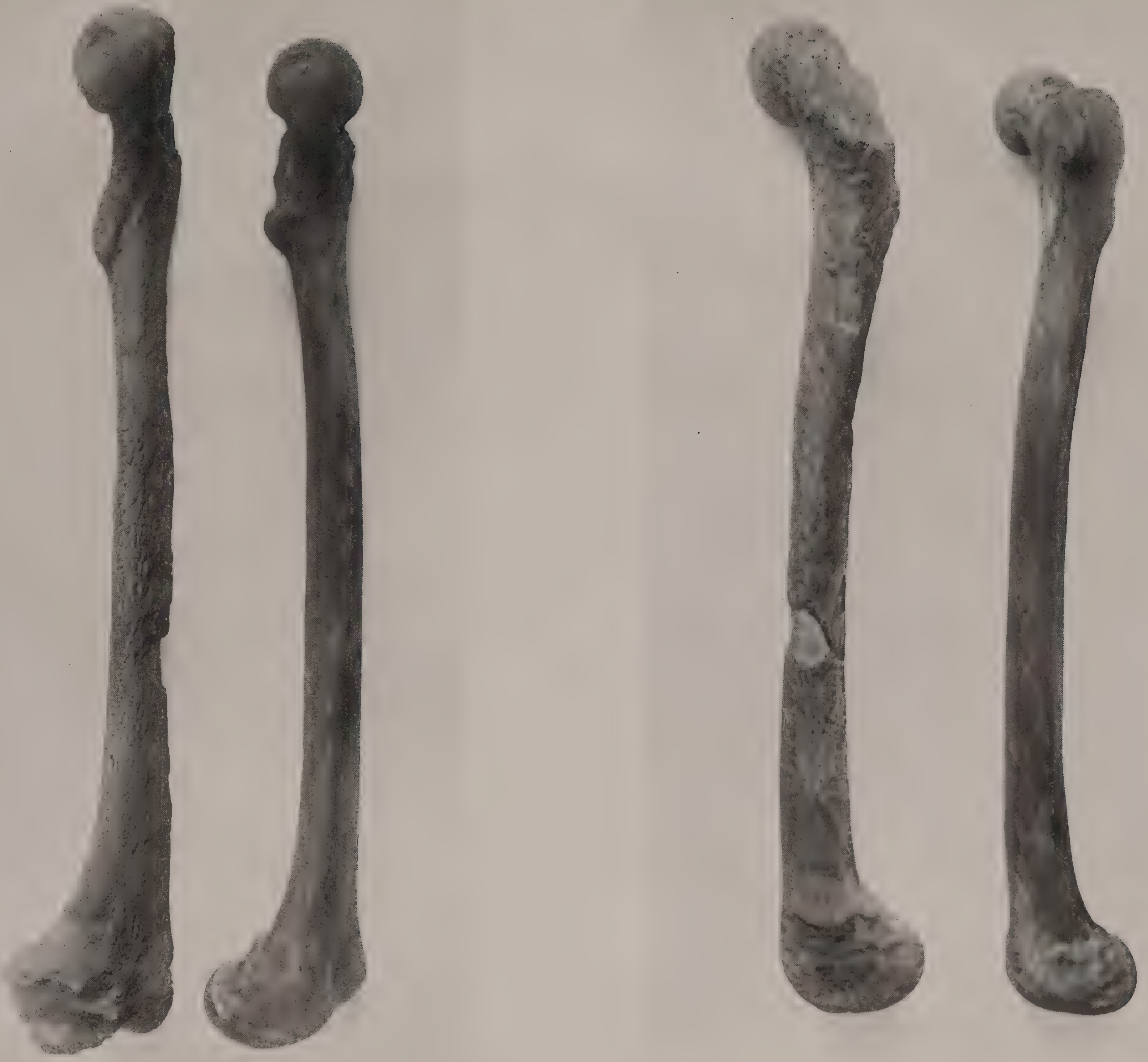
ERRATA

Plates LXXV and LXXVI. For *Pithecia monarchus* read *Pithecia monachus*.

Plate XCVI. *For* "Note the large lipped fovea of the latter" *read* "Note the large lipped fovea of the former."

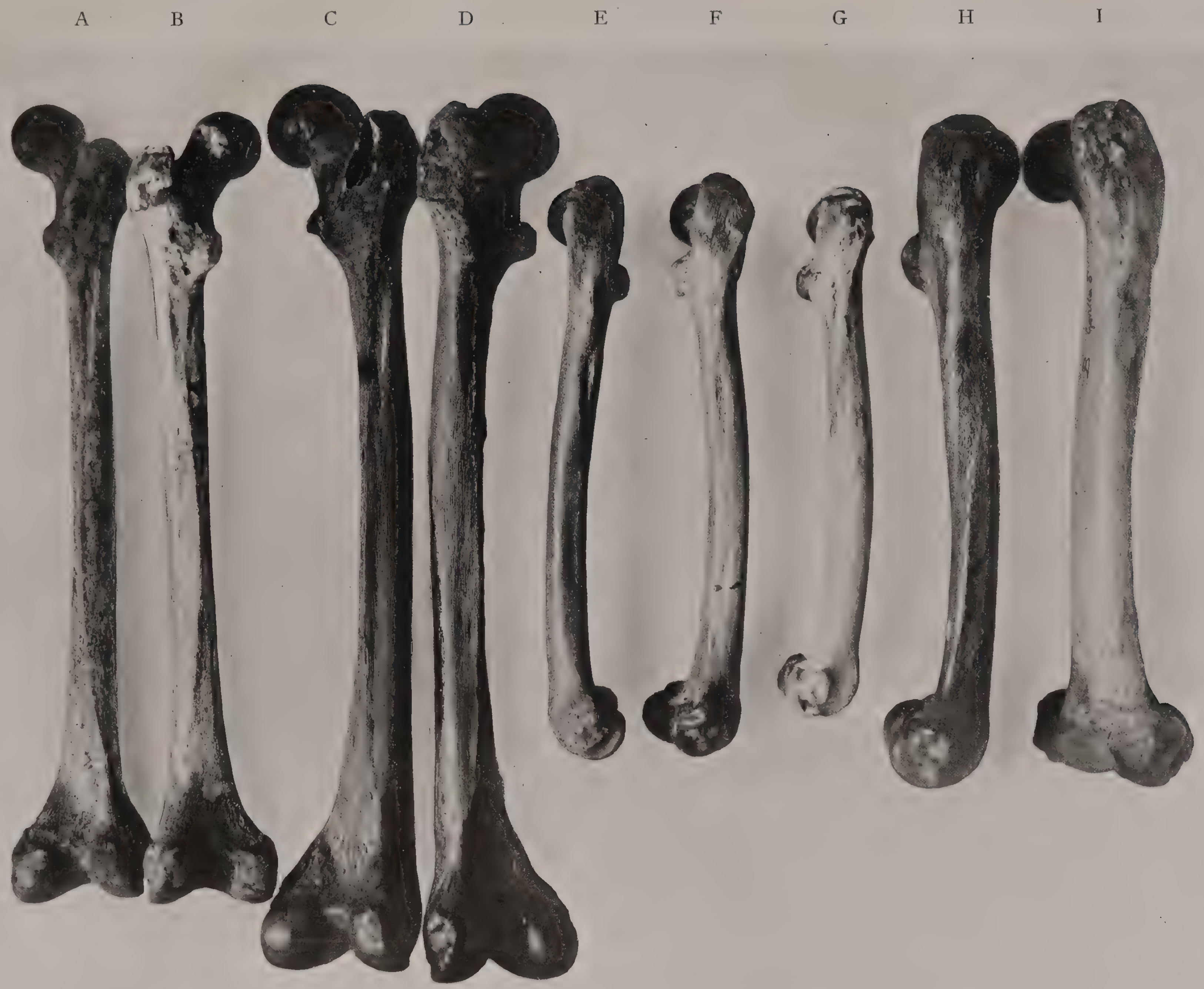


Galley Hill Femur (from cast) and Femur of Recent Man (on right) in posterior and anterior aspects.
Scale, about $\frac{5}{12}$ natural size.



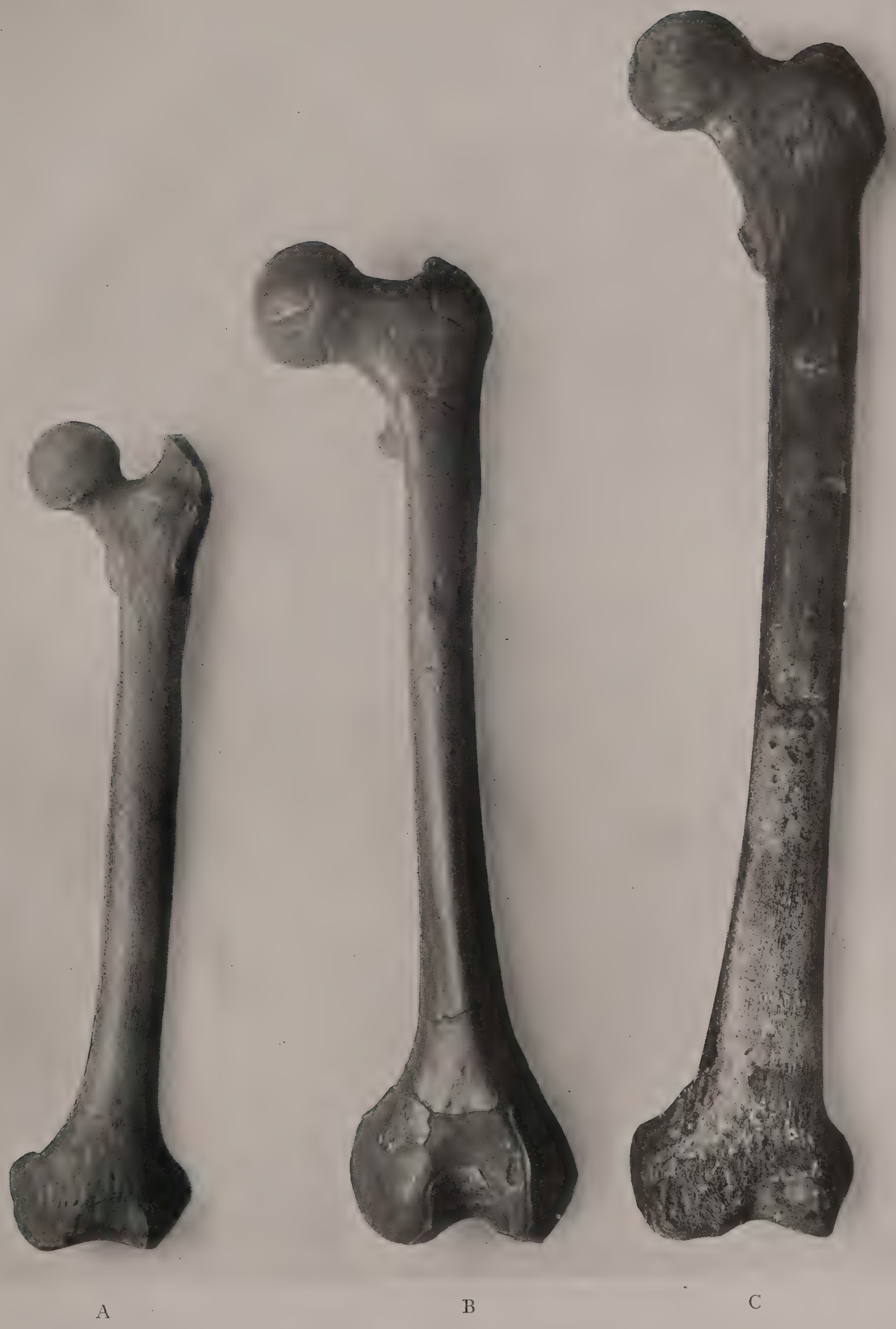
Galley Hill Femur (from cast) and Femur of Recent Man (on right) in mesial and lateral aspects.
Scale, about $\frac{5}{12}$ natural size.

Plate LXII

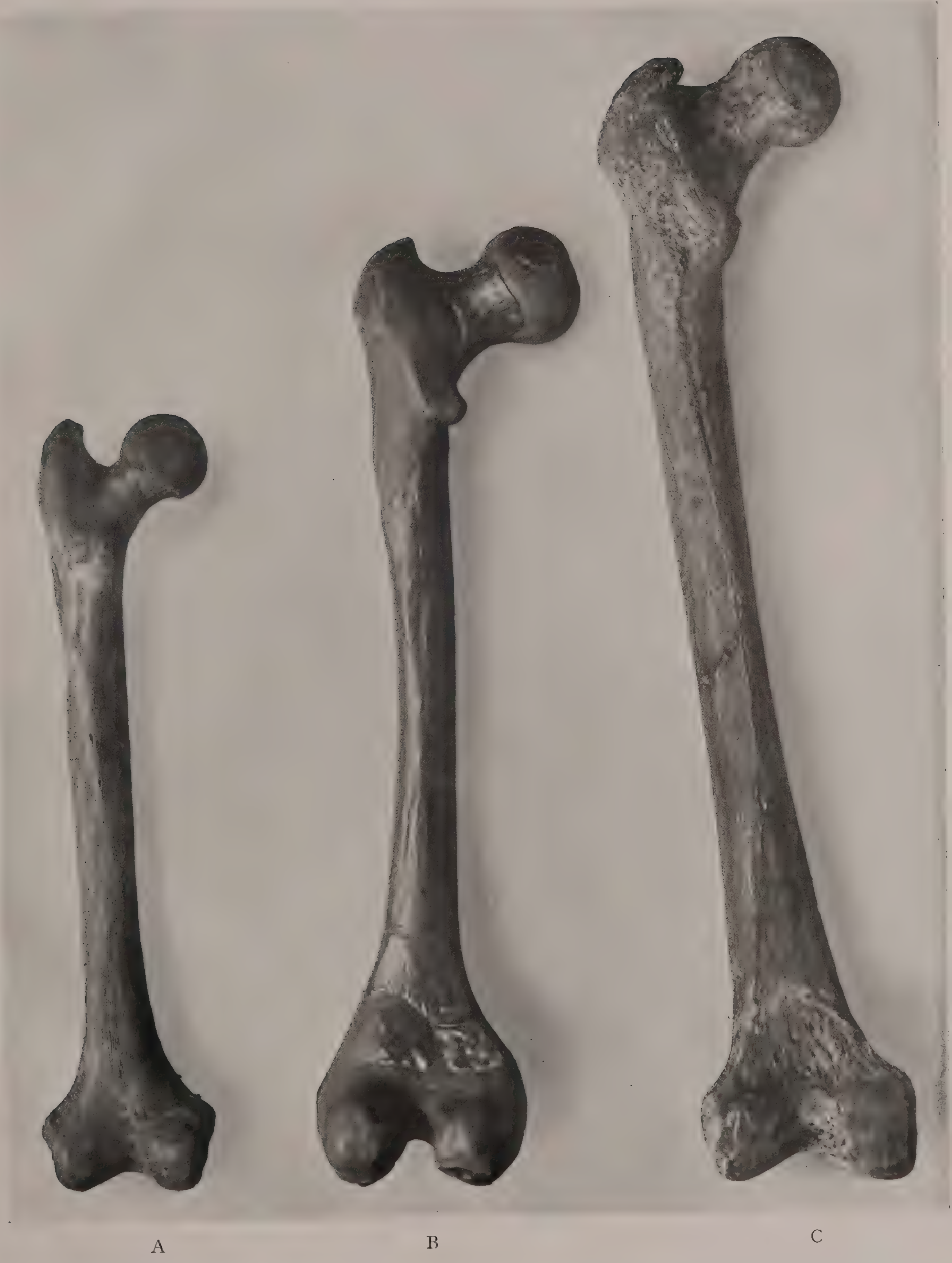


Fossa hypotrochanterica and Fossa angulolateralis.

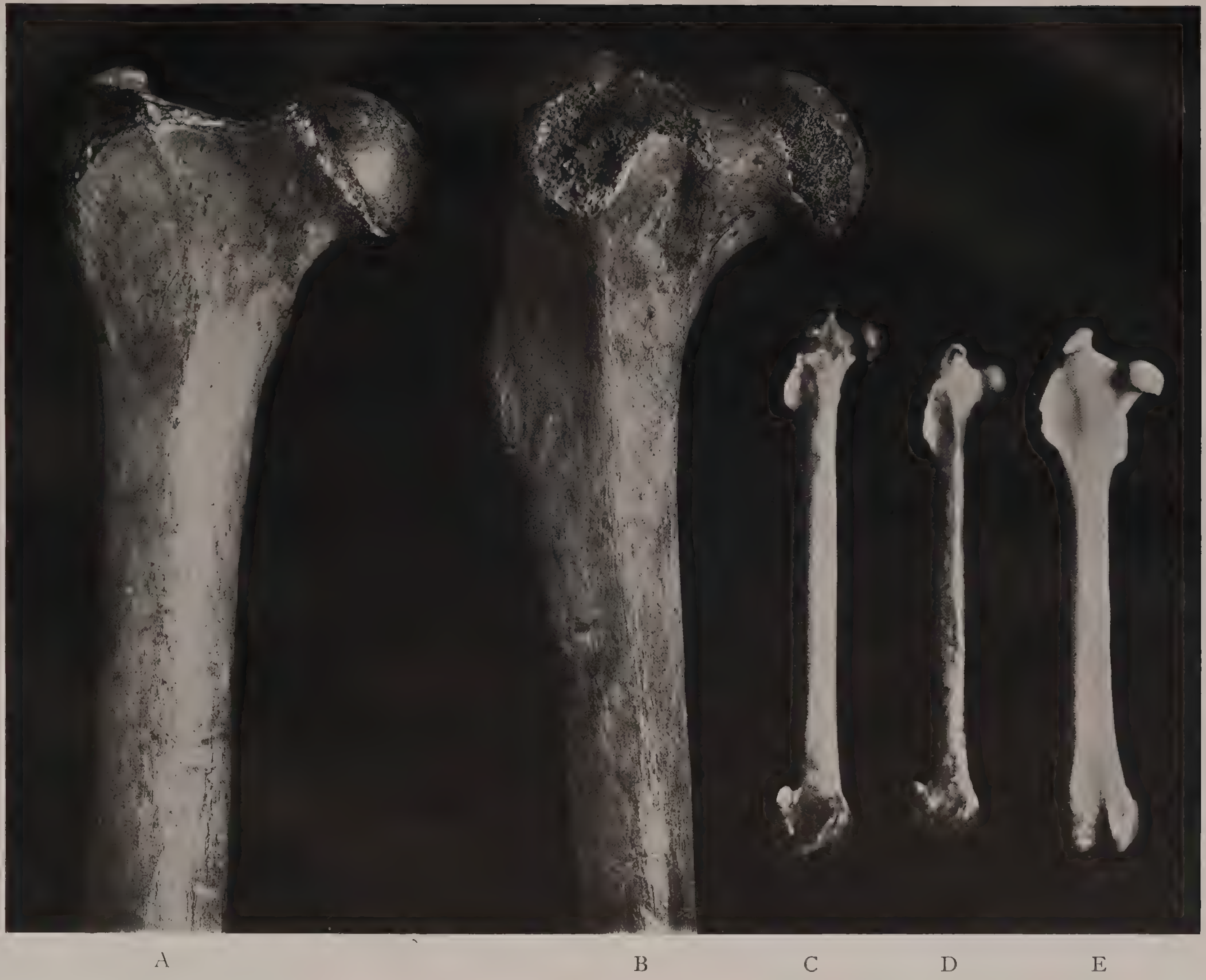
A, B and C, D, Fossa hypotrochanterica in paired Egyptian femora (Galton Laboratory). E, F, G, Fossa hypotrochanterica in Chimpanzee changing into Fossa angulolateralis. H, I, cases of latter fossa in gorilla femora.



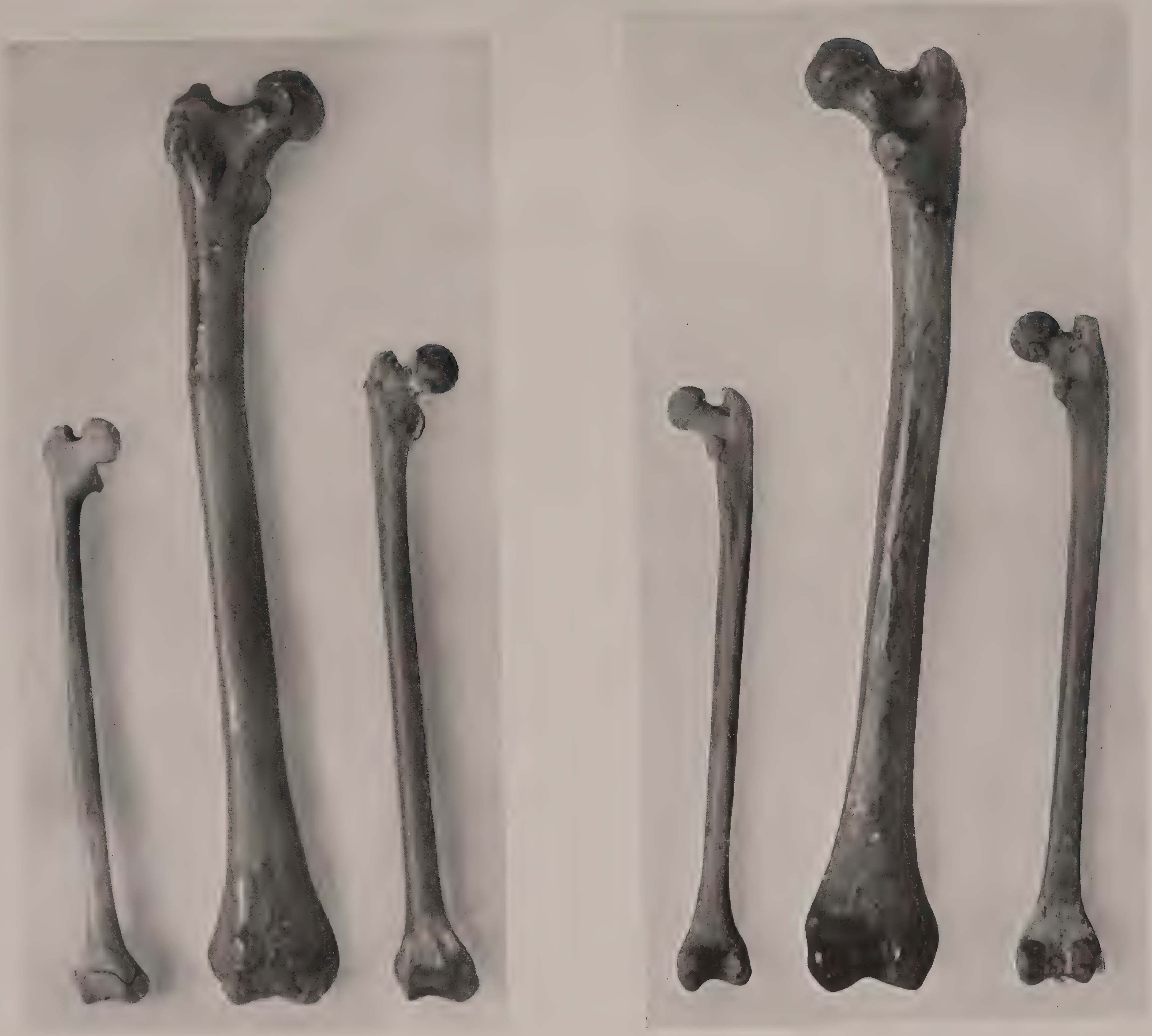
Anterior aspect of femora of Orang (A), of *Homo mousteriensis* (*Hauseri*) (B), and of Recent Man of primitive type (C). To indicate how Neanderthal man bridges as far as size characters are concerned the gap between anthropoid and recent man.



Posterior aspect of femora of Orang (A), of *Homo mousteriensis* (*Hauseri*) (B), and of Recent Man of primitive type (C). To indicate how Neanderthal man bridges in size the gap between the anthropoid and recent man.

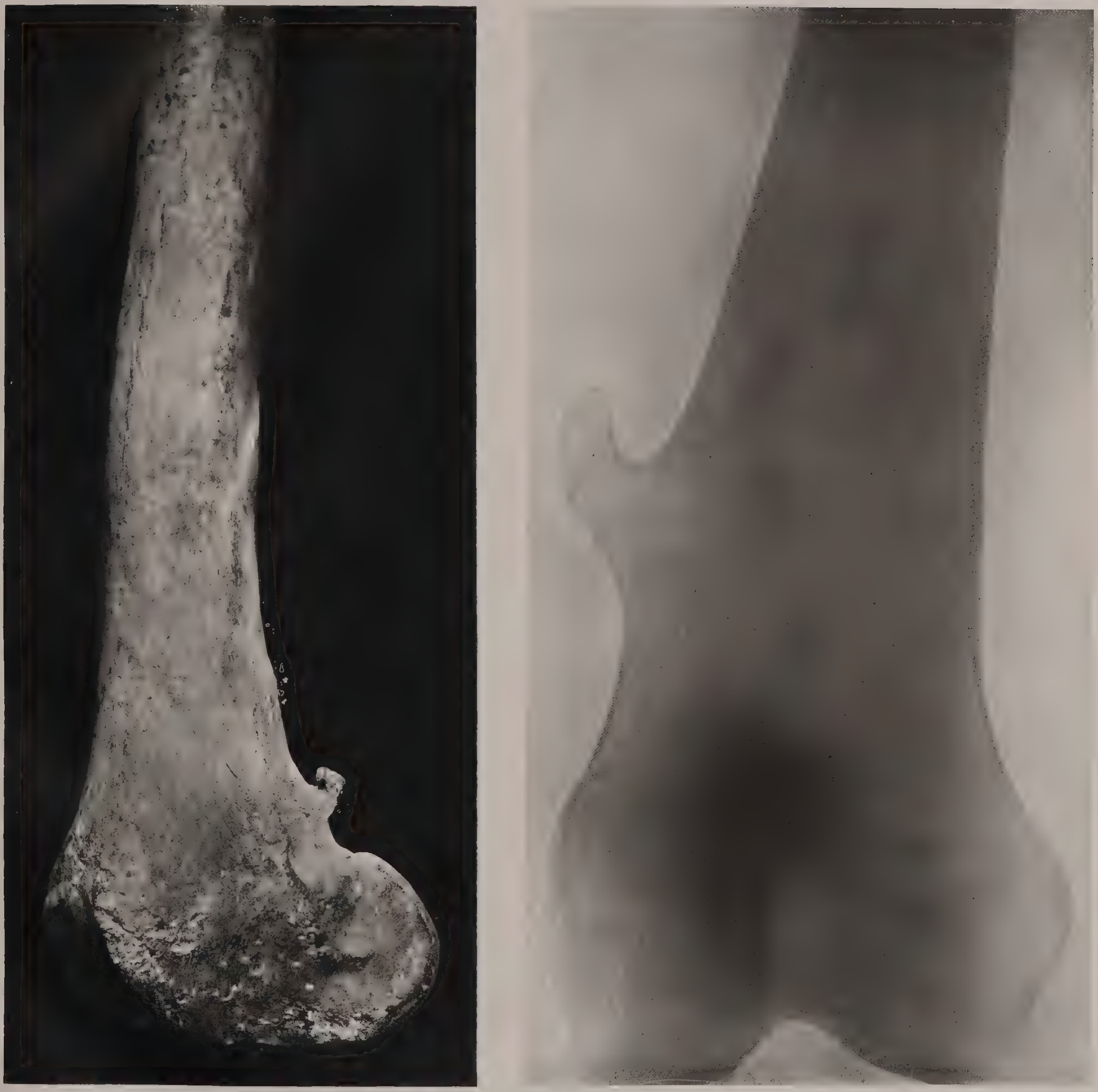


The “Frontal Pilaster.” B, lateral protrusion of the anterior face surmounted by ridge form of third trochanter and accompanied by a frontal pilaster in a human femur. C and D, the same as customary features of the Lemur's femora. A and E, modified forms of same features in the femora of Lion and Kangaroo respectively.

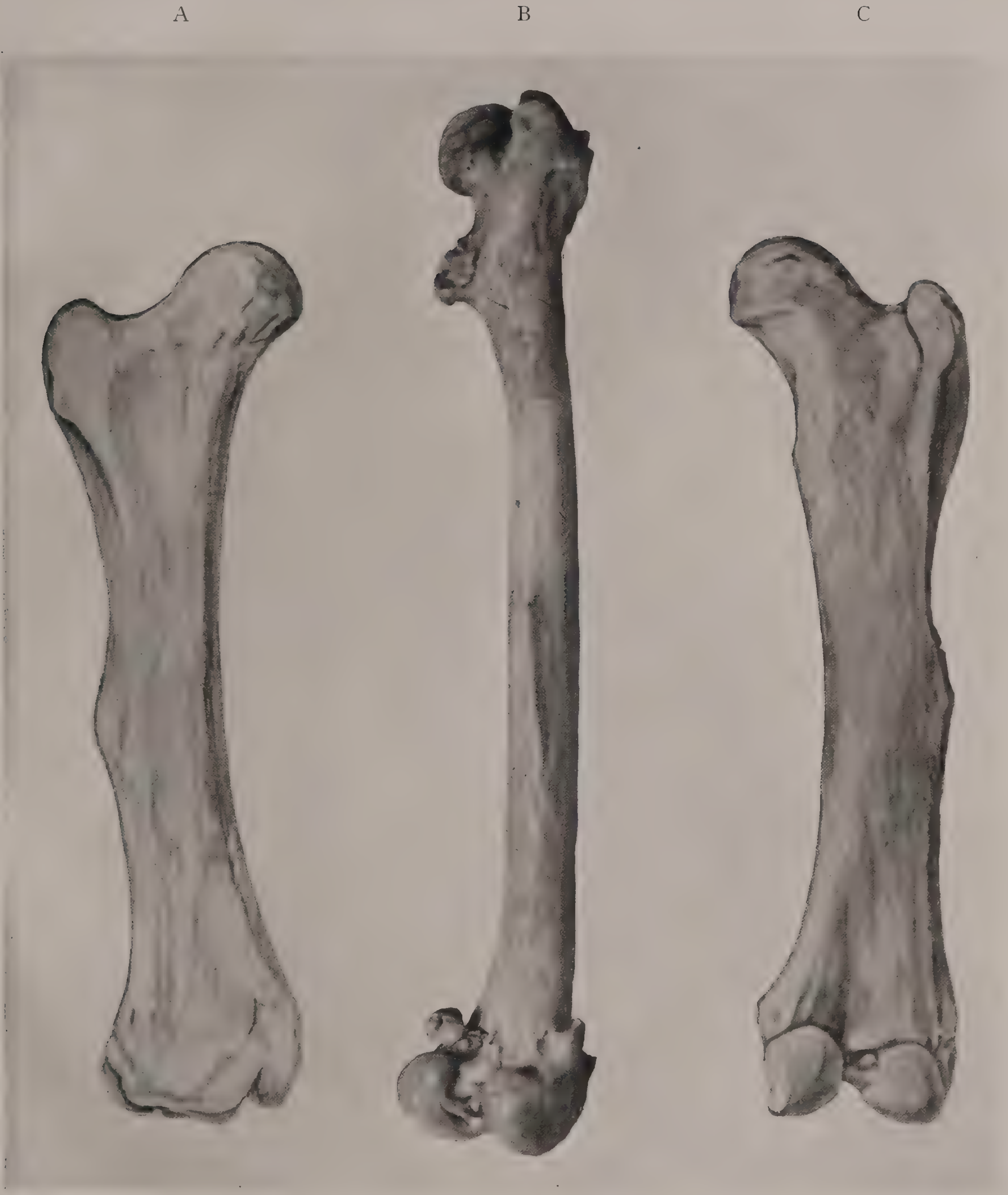


Anterior and Posterior aspects of femur of *Dryopithecus rhenanus* (*Pliohylobates Eppelsheimensis*) from cast at Royal College of Surgeons; flanked by femora of young and adult recent gibbons (*H. Mülleri*). $\frac{2}{3}$ natural size.

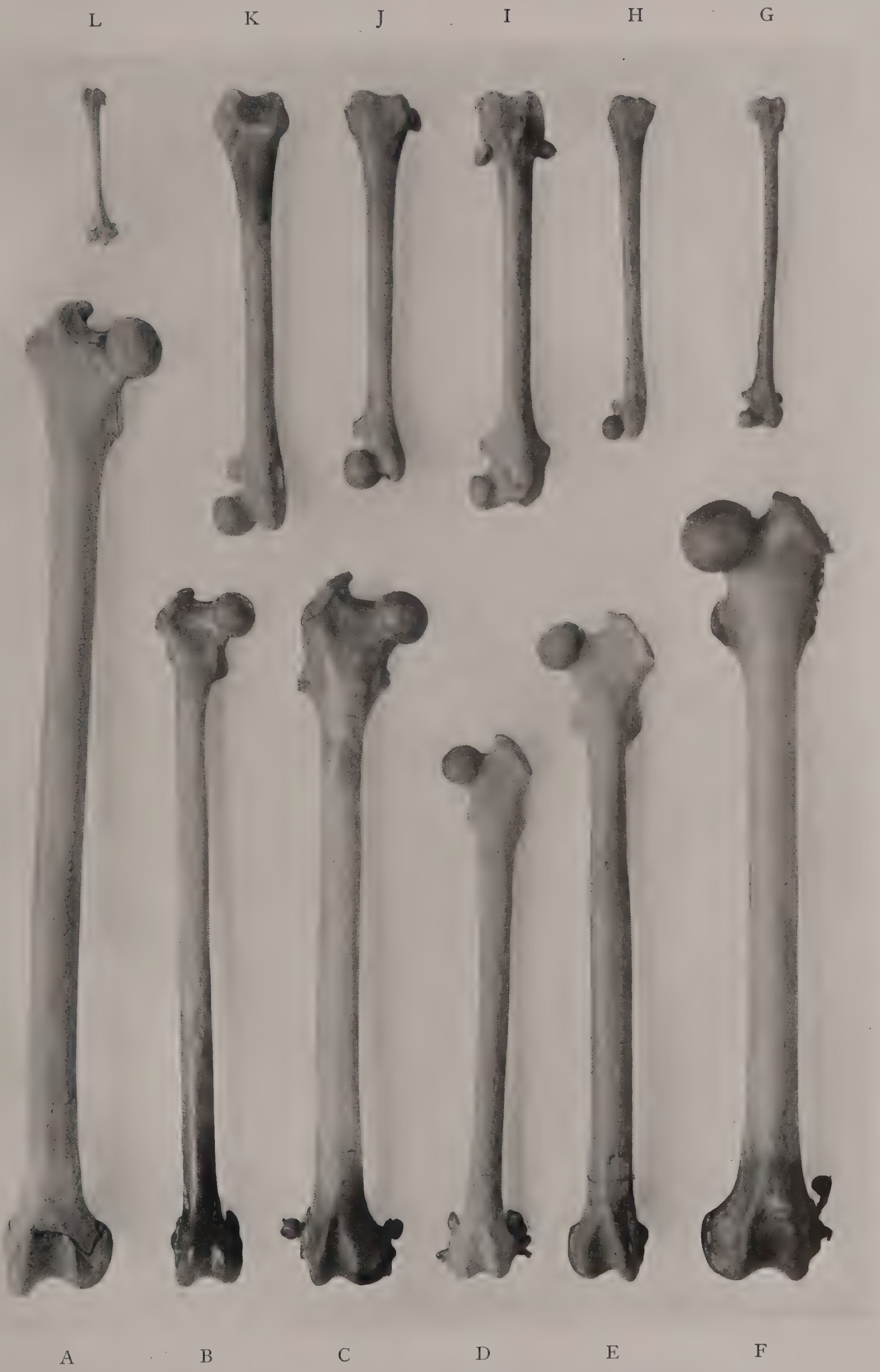
Plate LXVII



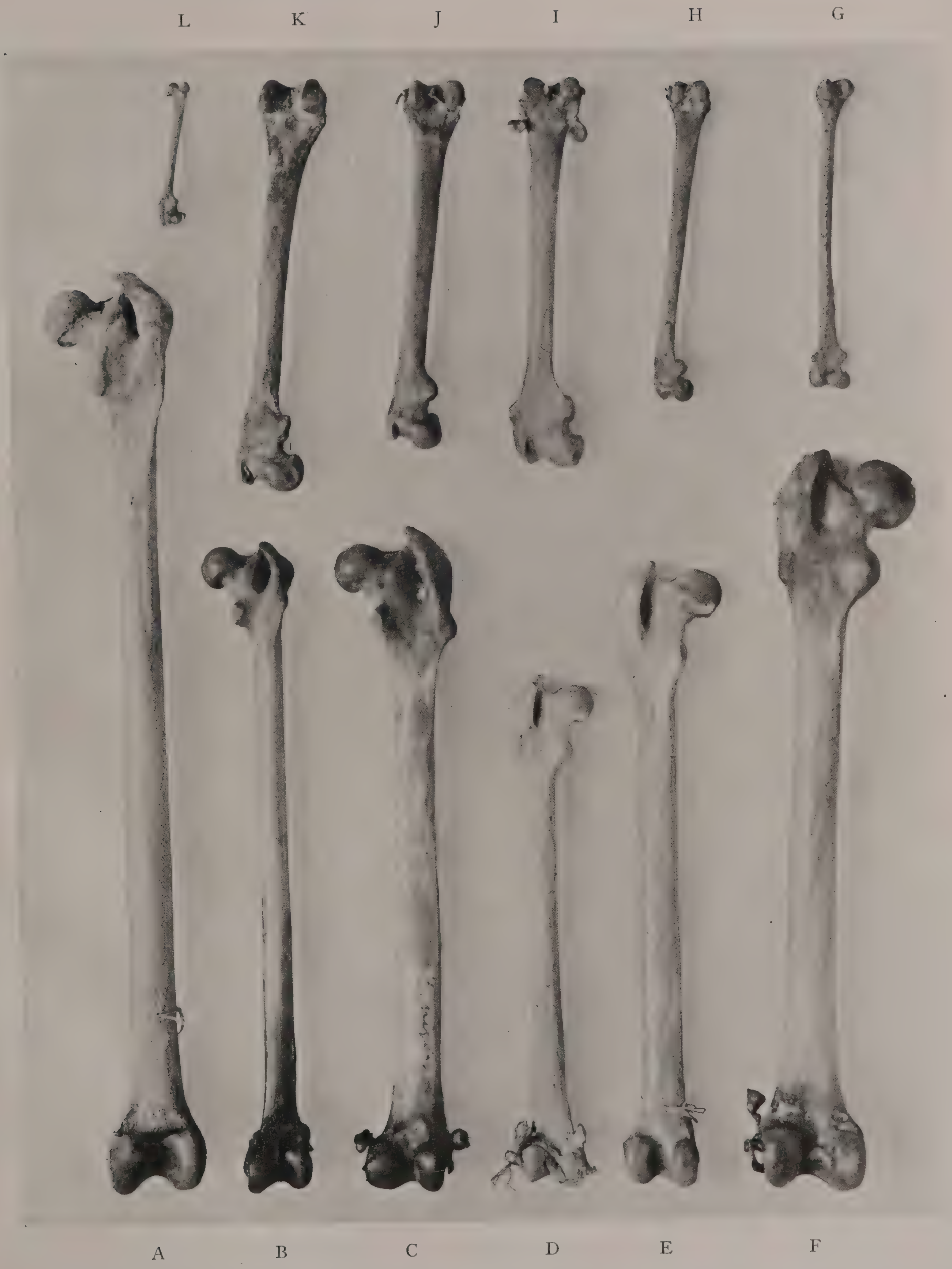
Illustrations of the *Processus supracondyloideus internus* of Gruber in a Lion's femur (Biometric Laboratory) and in a Human femur (skiagram from the Fulham Military Hospital, now at the Royal College of Surgeons). Compare Plate XXVI and Text p. 85 et seq.



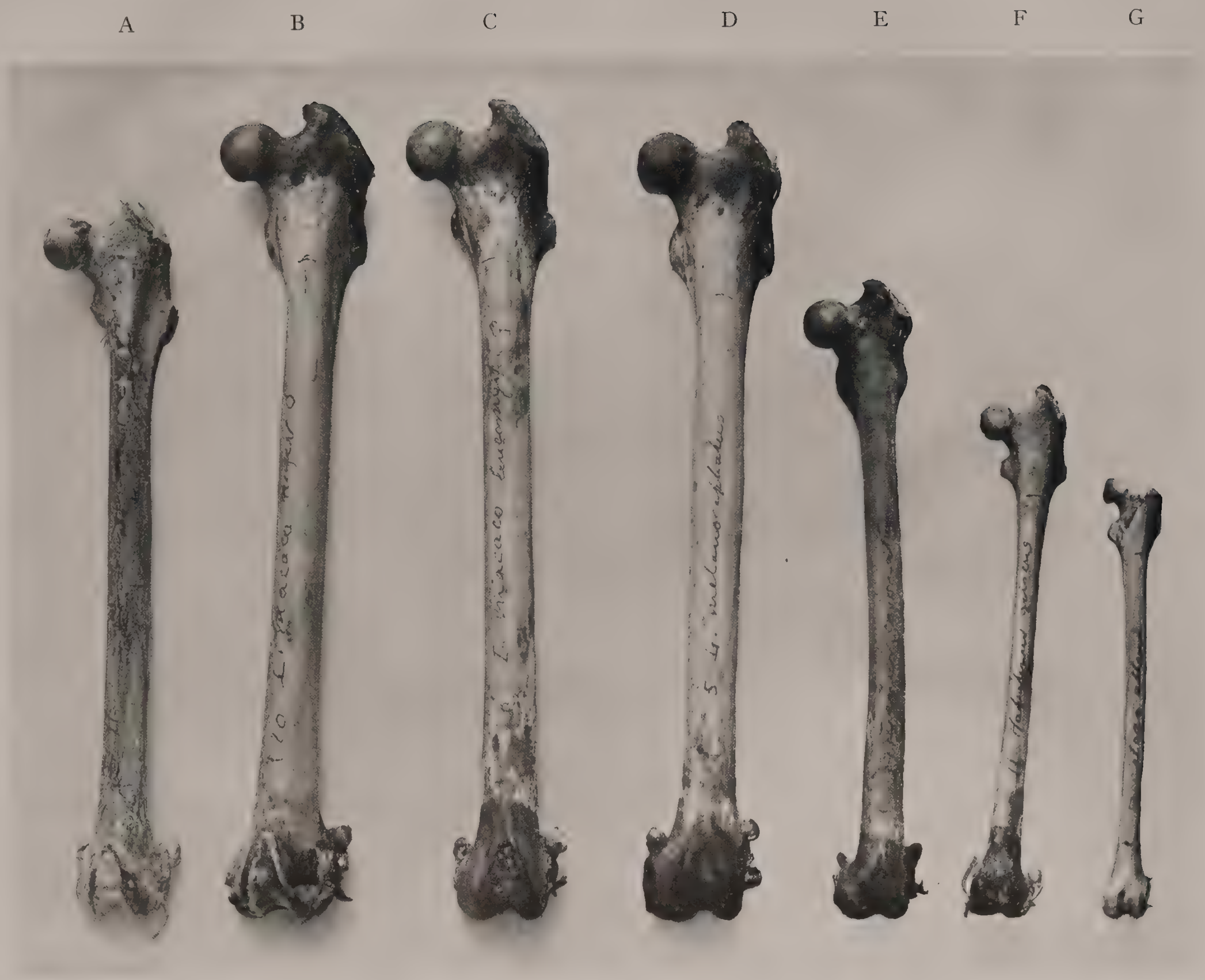
Example of Wilbrand's process (query "fourth" trochanter) in the femur of a Barbary Ape (*Macacus inuus*). B, Compare Plates XXIV, XXV, and XXVII. A and C, sketches after Andrews (Bibl. 95, Plate XVI) showing "fourth" trochanter in *Palaeomastodon Beadnelli* (Andrews) from the Fâyum. B = natural size; A and C = $\frac{1}{5}$ natural size.



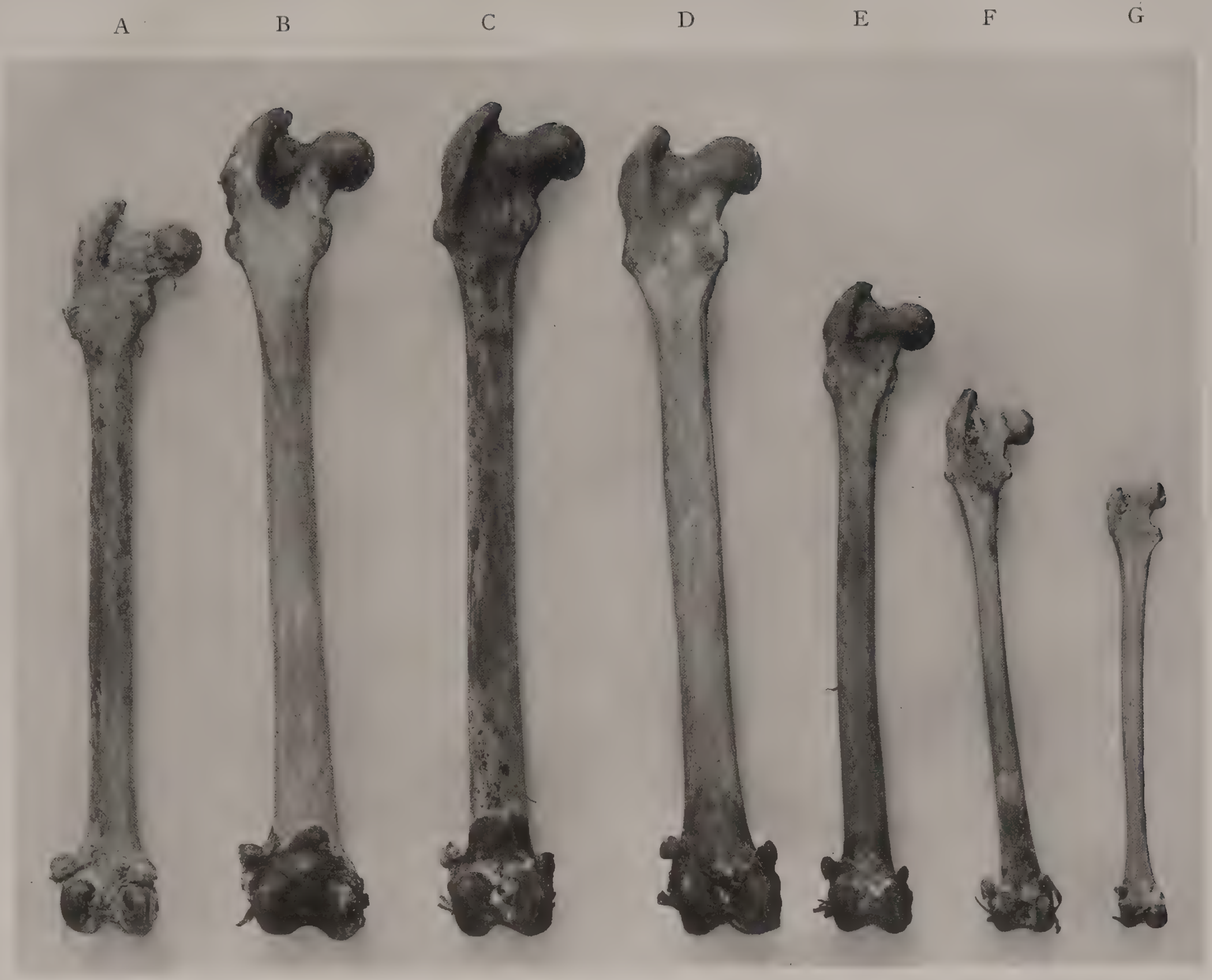
Anterior aspect of femora of the Lemuroidea. A, *Propithecus diadema.* B, *Avahis laniger.* C, *L. macaco* (*leucomystax*). D, *L. catta.* E, *L. rubriventer.* F, *L. macaco* (*niger*). G, *Tarsius spectrum.* H, *Loris gracilis.* I, *Galago crassicaudata.* J, *Nycticebus javanicus.* K, *Perodicticus potto.* L, *Chirogaleus.* Natural size.



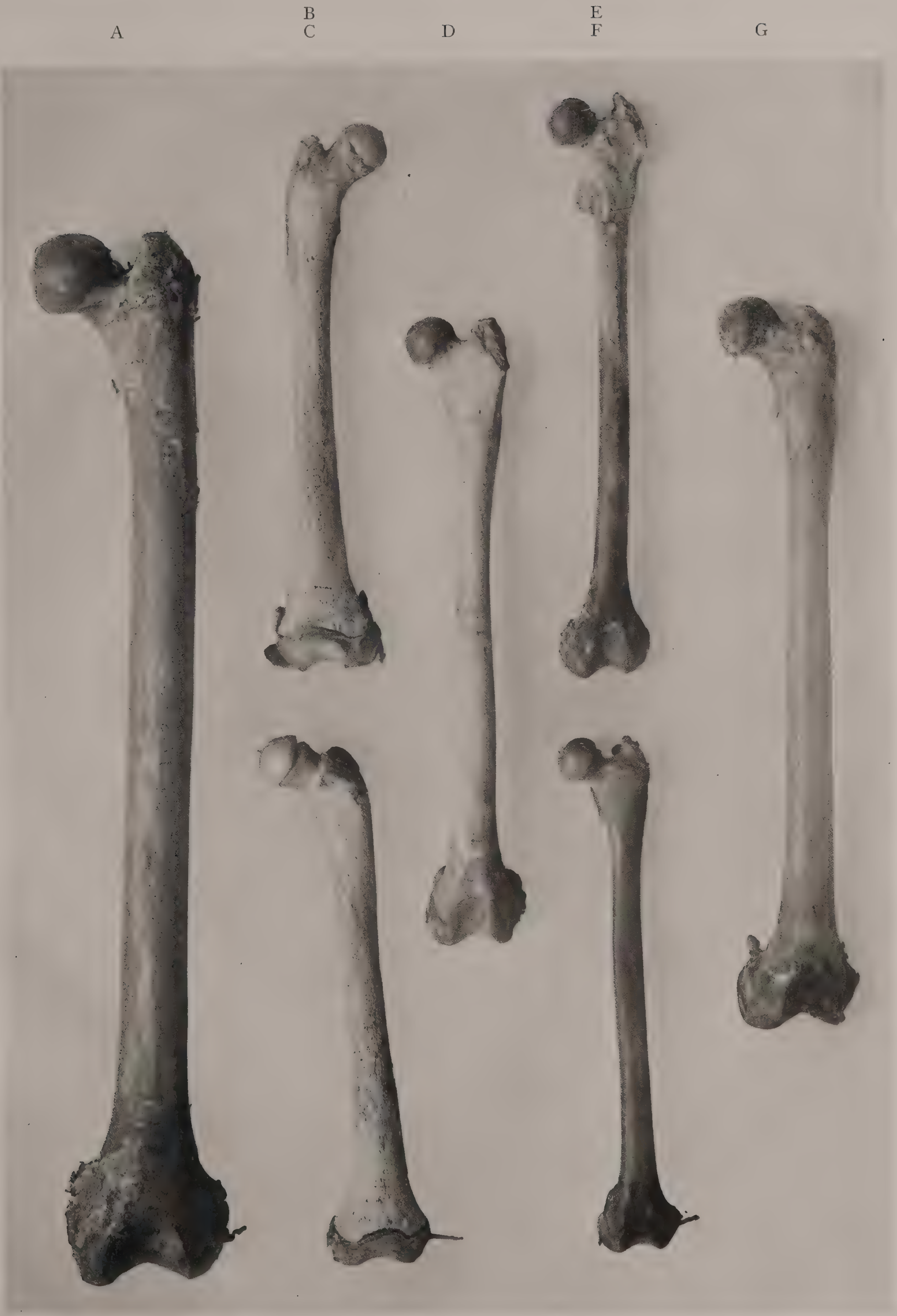
Posterior aspect of femora of the Lemuroidea. A, *Propithecus diadema*. B, *Avahis laniger*. C, *L. macaco* (*leucomystax*). D, *L. catta*. E, *L. rubriventer*. F, *L. macaco* (*niger*). G, *Tarsius spectrum*. H, *Loris gracilis*. I, *Galago crassicaudata*. J, *Nycticebus javanicus*. K, *Perodicticus potto*. L, *Chirogaleus*. Natural size.


A
B
C
D
E
F
G
10 L. macaco niger
L. macaco leucomyst
5 L. melanocephalus
11 Hapalemur griseus

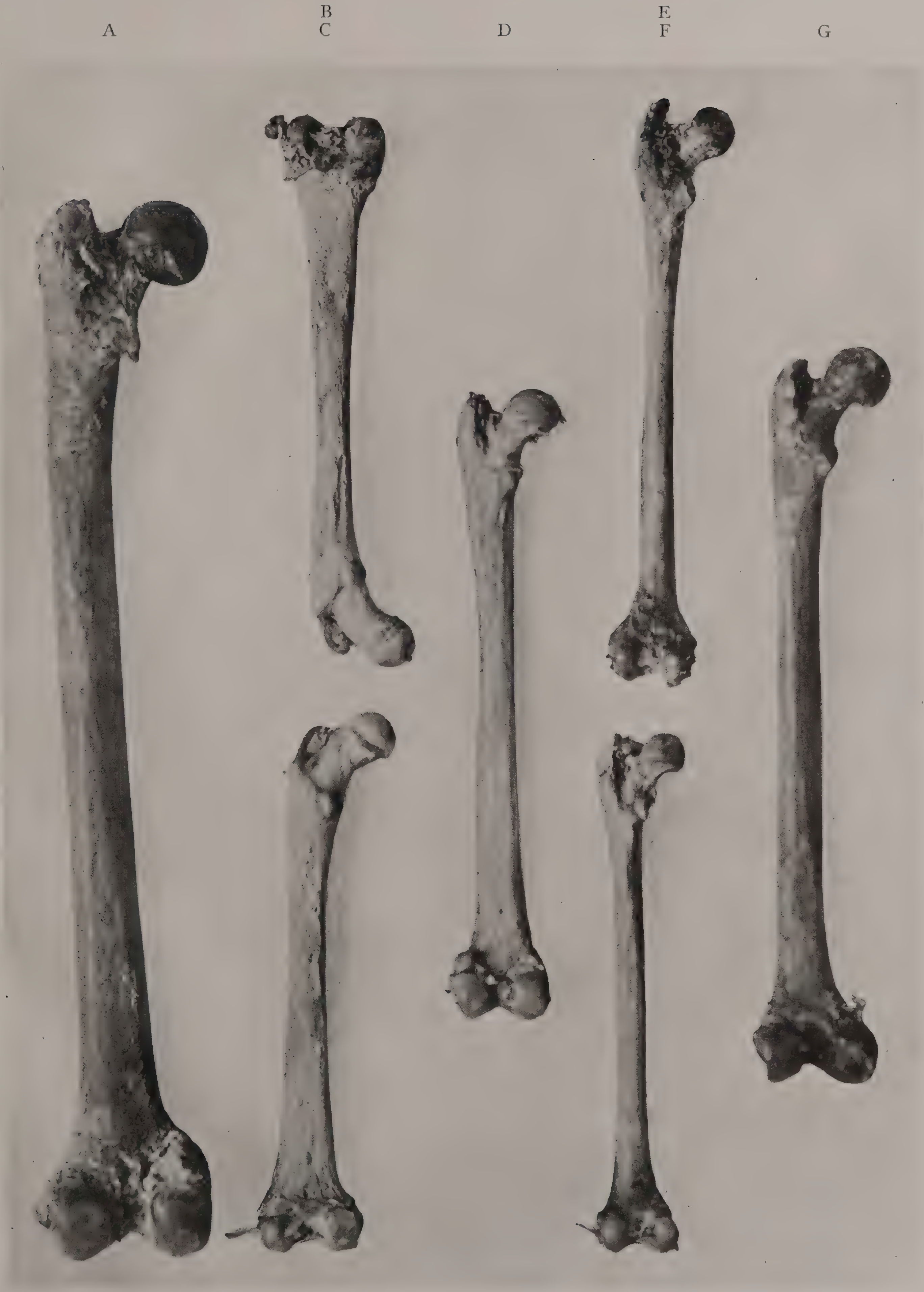
Anterior aspect of femora of the Lemuroidea (see Plate LXIX). A, *L. rufifrons* (note "frontal" pilaster). B, *L. macaco* (*niger*). C, *L. macaco* (*leucomystax*). D, *L. melanocephalus* (*Lemur mongoz*). E, *L. coronatus*. F, *Hapalemur griseus*. G, *Galago alleni*. Natural size.



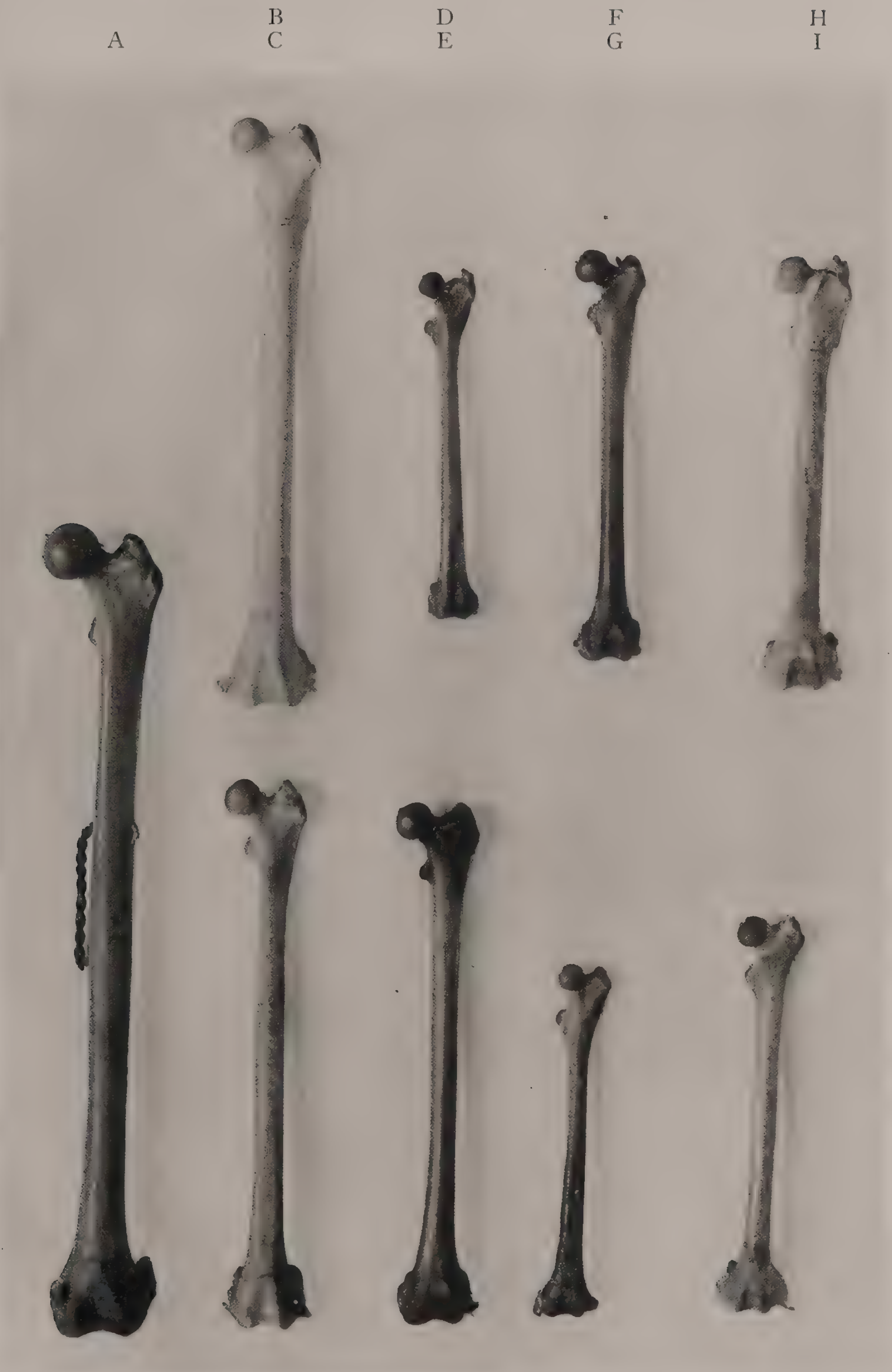
Posterior aspect of femora of the Lemuroidea (see Plate LXIX). A, *L. rufifrons*. B, *L. macaco* (*niger*). C, *L. macaco* (*leucomystax*). D, *L. melanocephalus* (*Lemur mongoz*). E, *L. coronatus*. F, *Hapalemur griseus*. G, *Galago alleni*. Natural size.



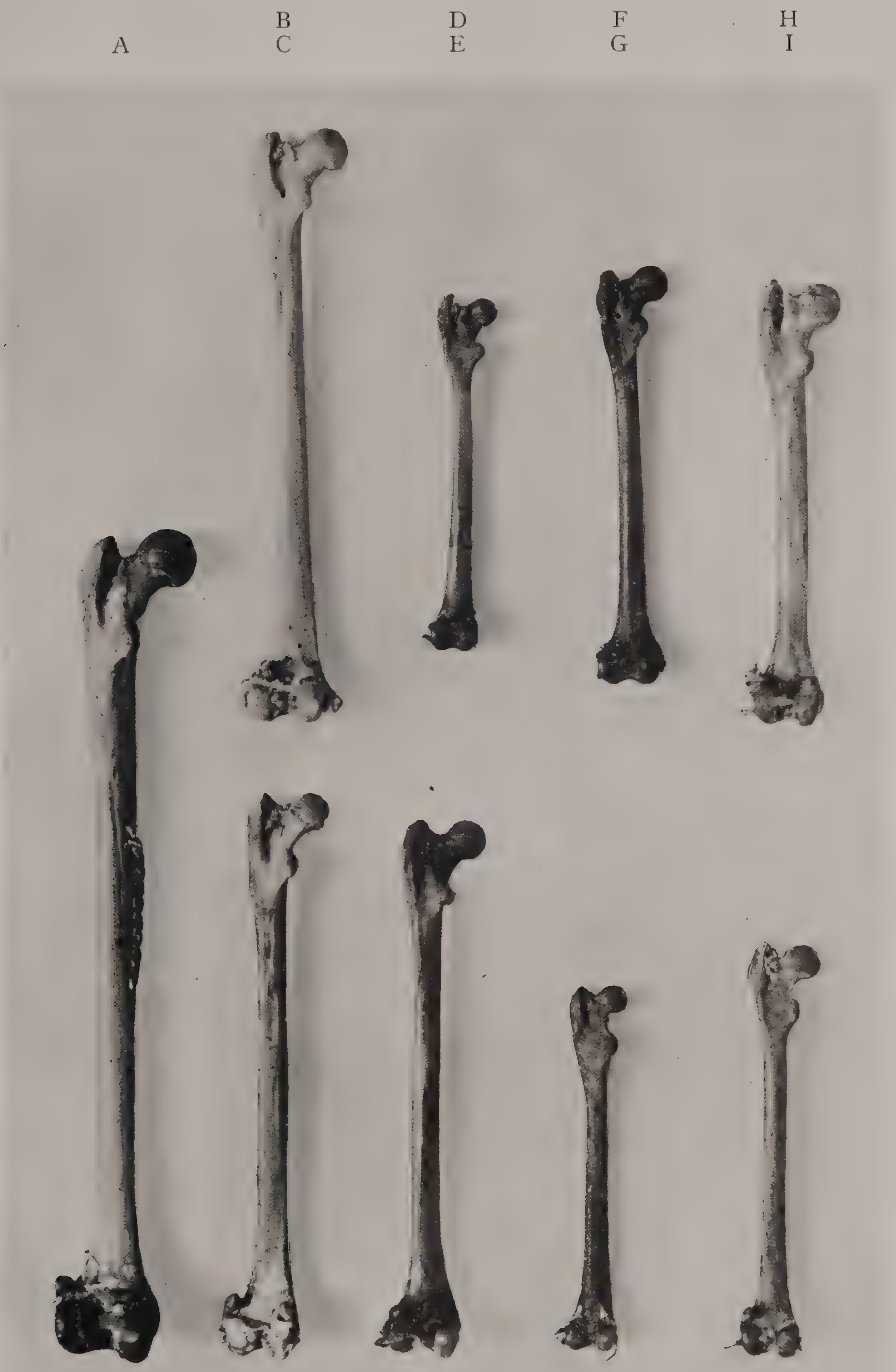
Anterior aspect of femora of the Cebidae. A, *Ateles ater.* B, C, *Lagothrix humboldtii*, R. and L. D, *Cebus capucinus.* E, *Cebus flavius.* F, *Cebus* —? G, *Mycetes palliatus.* Natural size.



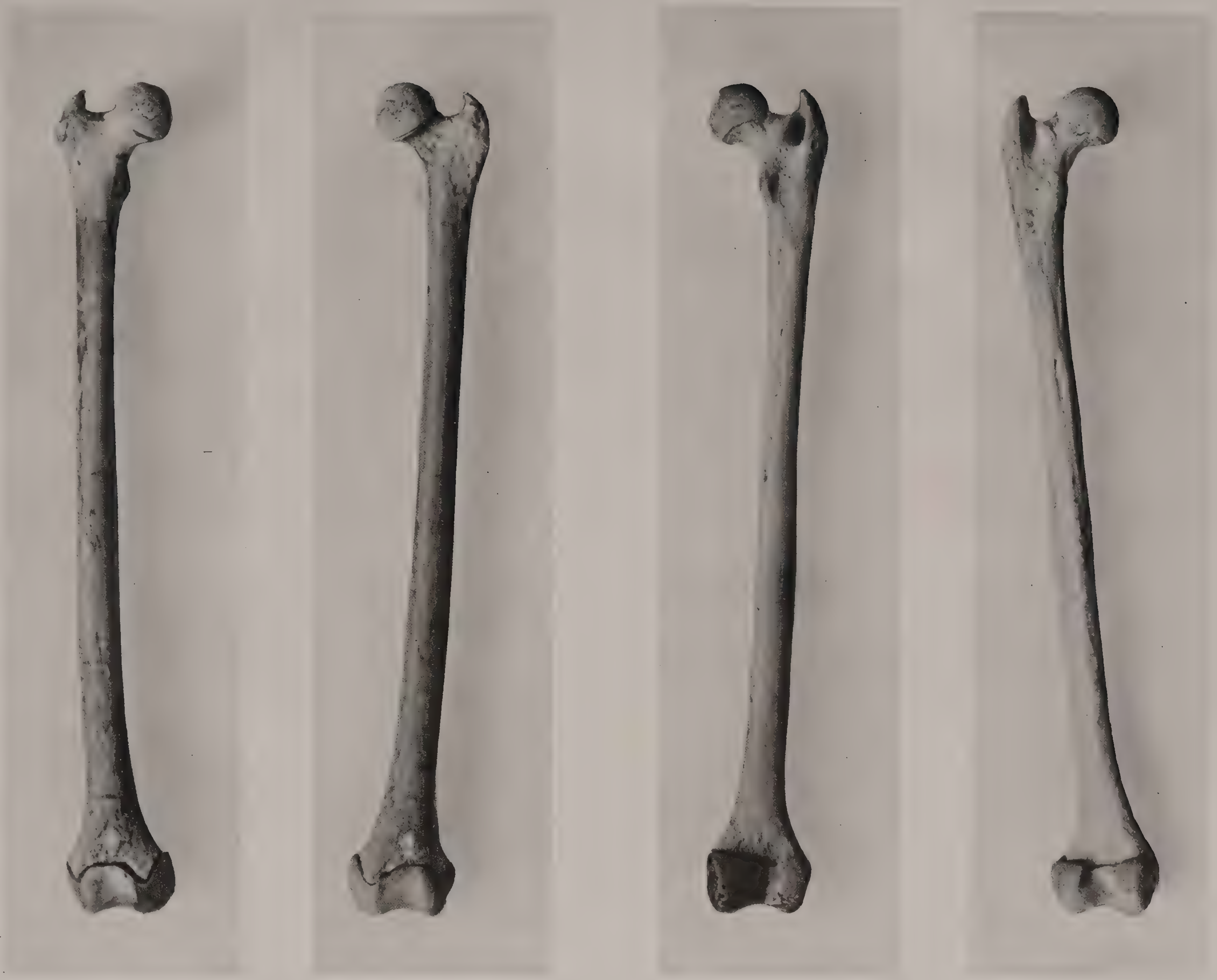
Posterior aspect of femora of the Cebidae. A, *Ateles ater*. B, C, *Lagothrix humboldtii*, R. and L. D, *Cebus capucinus*. E, *Cebus flavius*. F, *Cebus* —? G, *Mycetes palliatus*. Natural size.



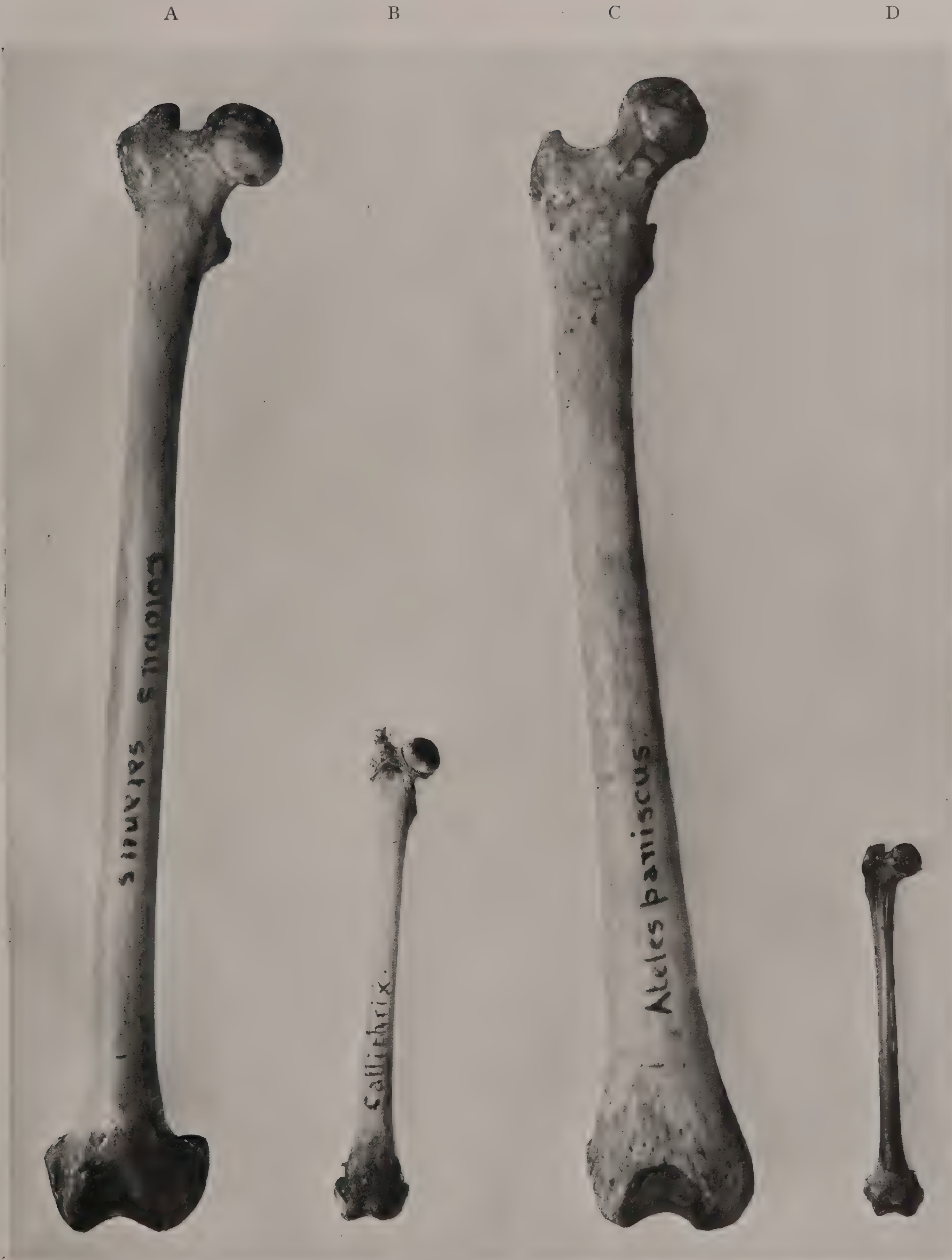
Anterior aspect of femora of the Cebidae. A, *Pithecia monarchus*. B, *Chrysothrix sciurea* II. C, *Chrysothrix sciurea* I. D, *Jacchus* —? I. E, *Jacchus* —? II. F, *Jacchus auritus*. G, *Hapale jacchus*. H, *Midas chrysoleucus*. I, *Midas ursulus* I. Natural size.



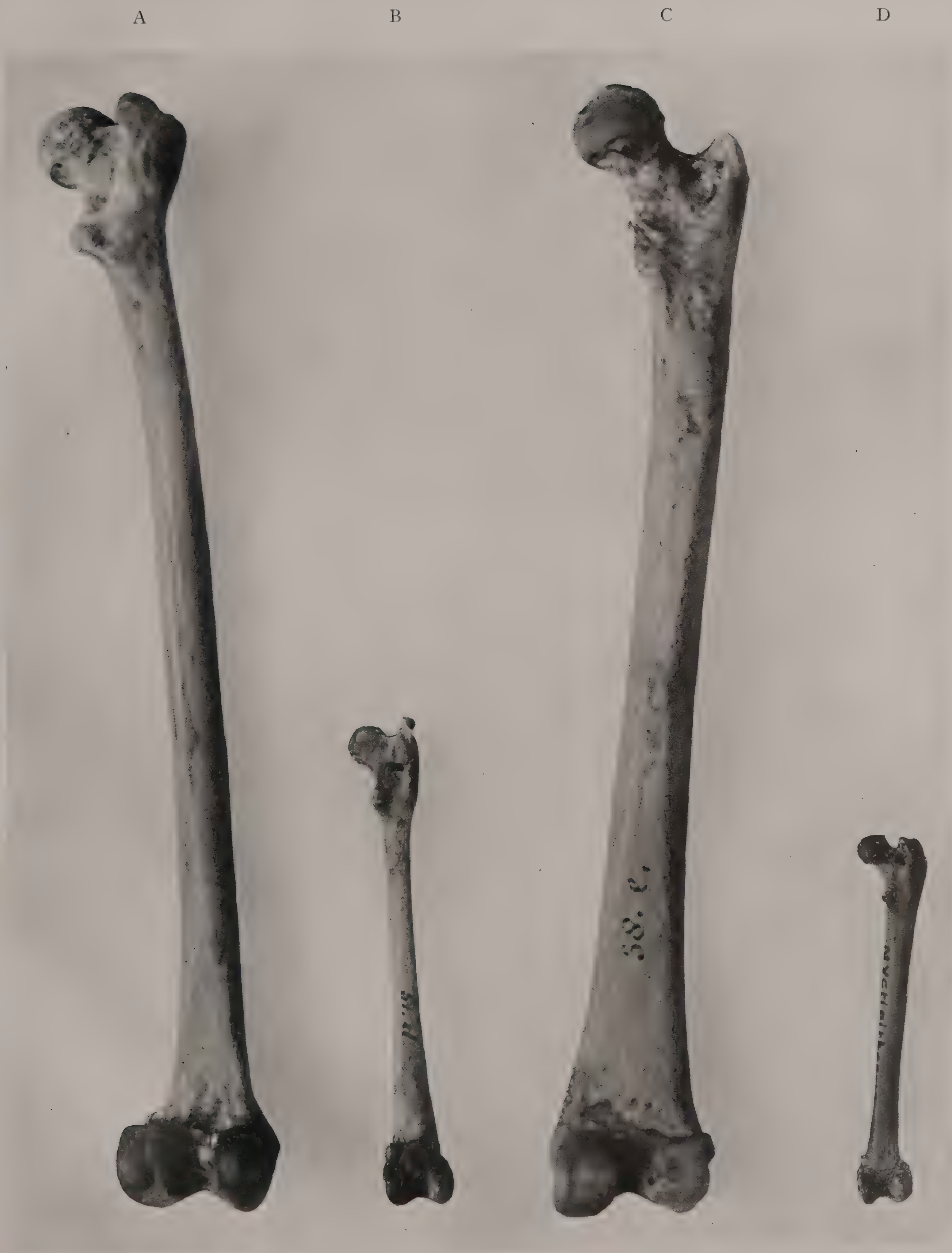
Posterior aspect of femora of the Cebidae. A, *Pithecia monarchus*. B, *Chrysothrix sciurea* II. C, *Chrysothrix sciurea* I. D, *Jacchus* —? I. E, *Jacchus* —? II. F, *Jacchus auritus*. G, *Hapale jacchus*. H, *Midas chrysoleucus*. I, *Midas ursulus* I. Natural size.



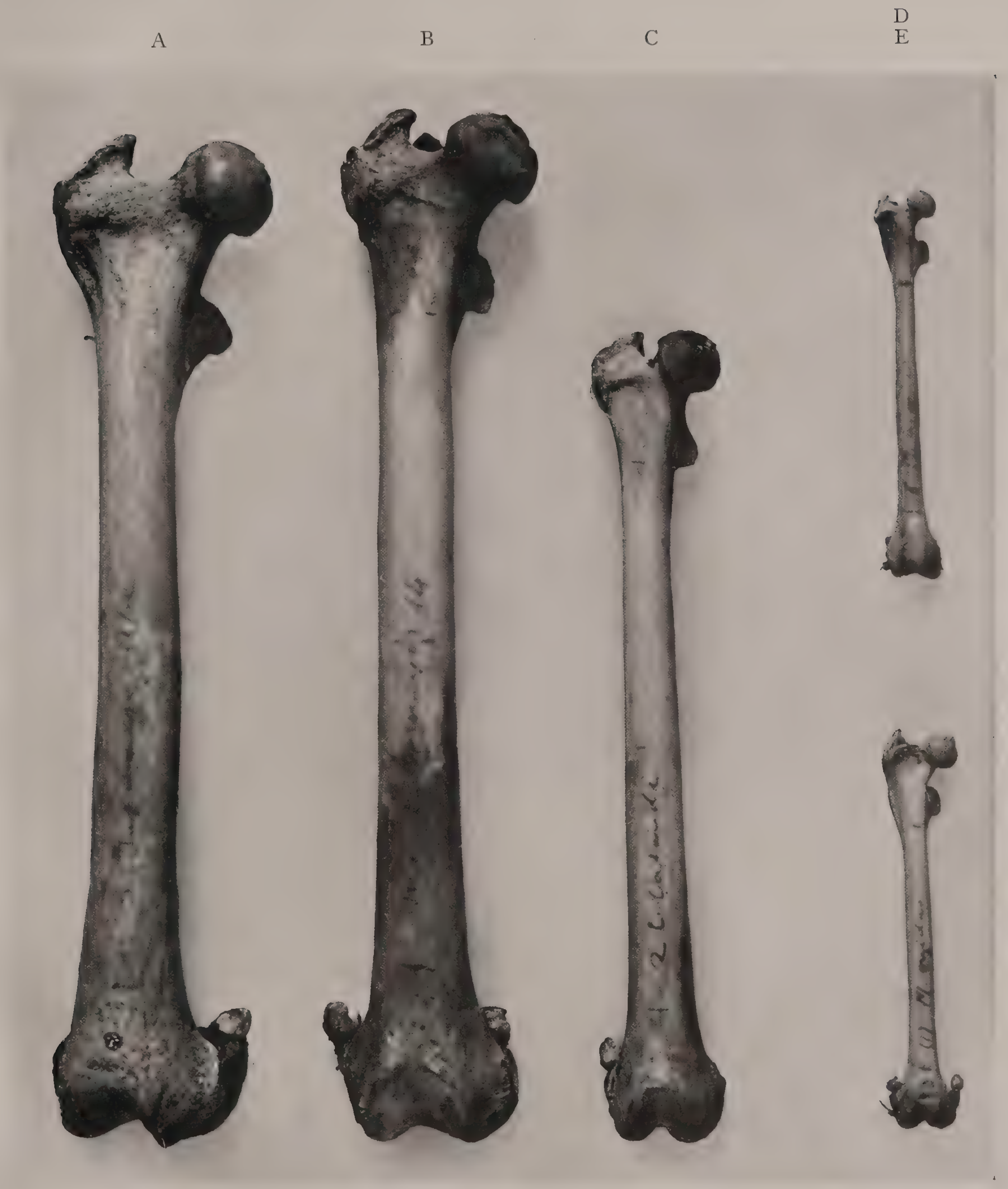
ANTERIOR AND POSTERIOR ASPECTS OF R. AND L. FEMORA OF A YOUNG SPECIMEN OF *BRACHYURUS RUBICUNDUS*. FROM A SKELETON KINDLY LENT TO THE AUTHORS BY THE ZOOLOGICAL SOCIETY OF LONDON. NOTE THE POSTERIOR FOSSA ON BOTH POSTERIOR ASPECTS. NATURAL SIZE.


A
B
C
D
Colobus satanus
Callithrix.
Ateles paniscus

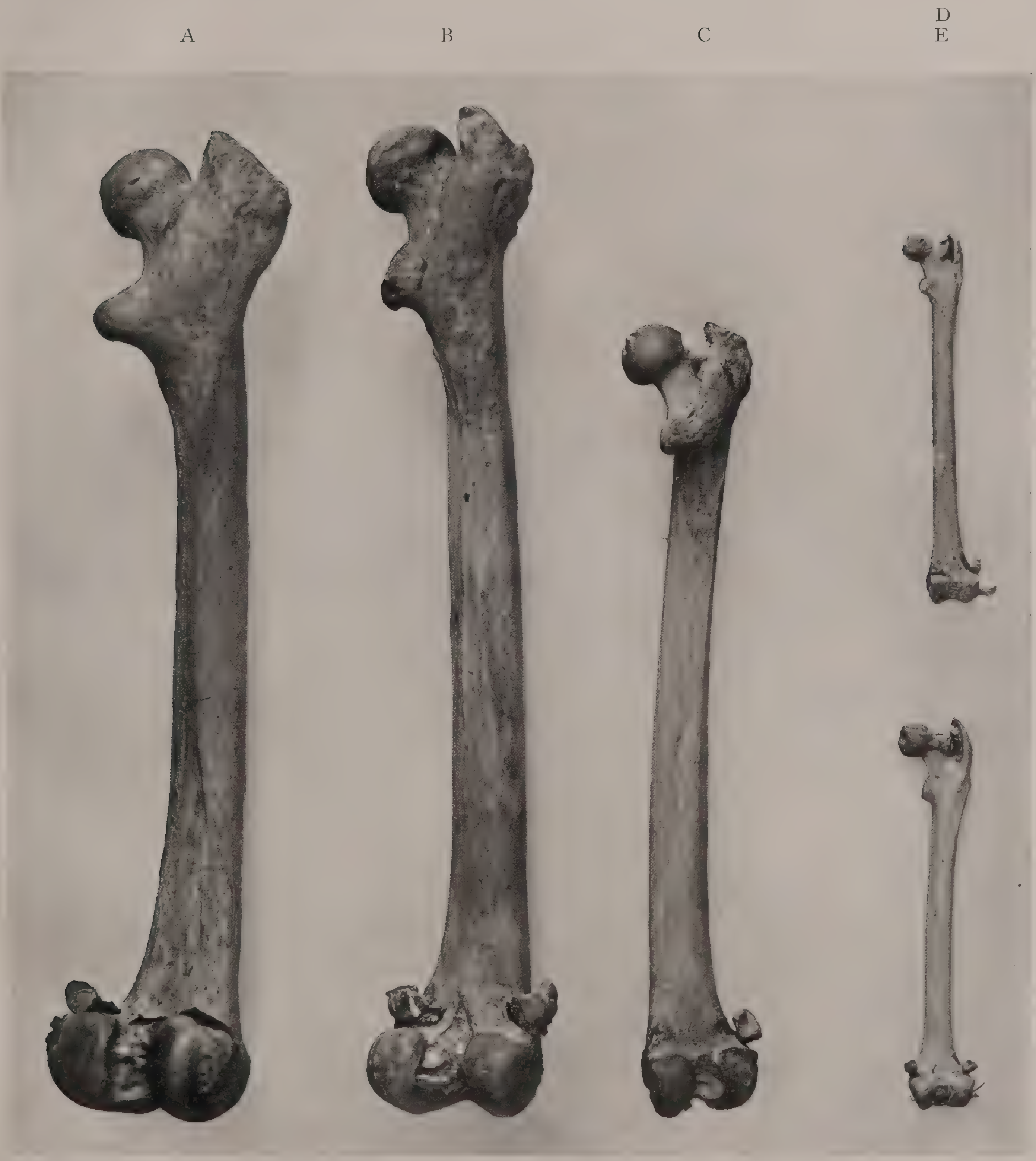
Anterior aspect of femora of Simiadae (A) and Cebidae (B, C, D). A, *Colobus satanus.* B, *Callithrix personatus.* C, *Ateles paniscus.* D, *Nyctipithecus lemurinus.* Natural size.



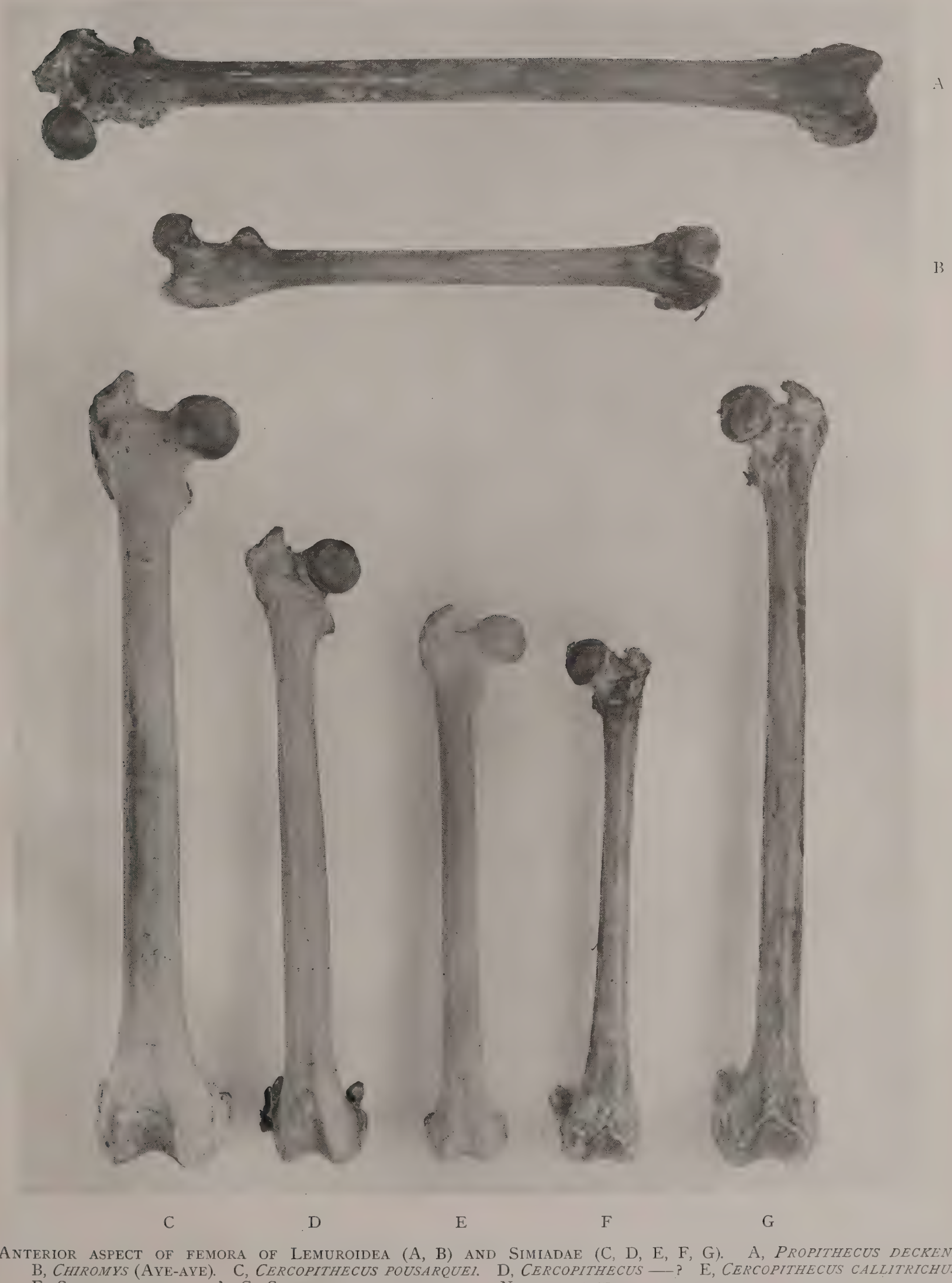
Posterior aspect of femora of Simiadae (A) and Cebidae (B, C, D). A, *Colobus satanus.* B, *Callithrix personatus.* C, *Ateles paniscus.* D, *Nyctipithecus lemurinus.* Natural size.



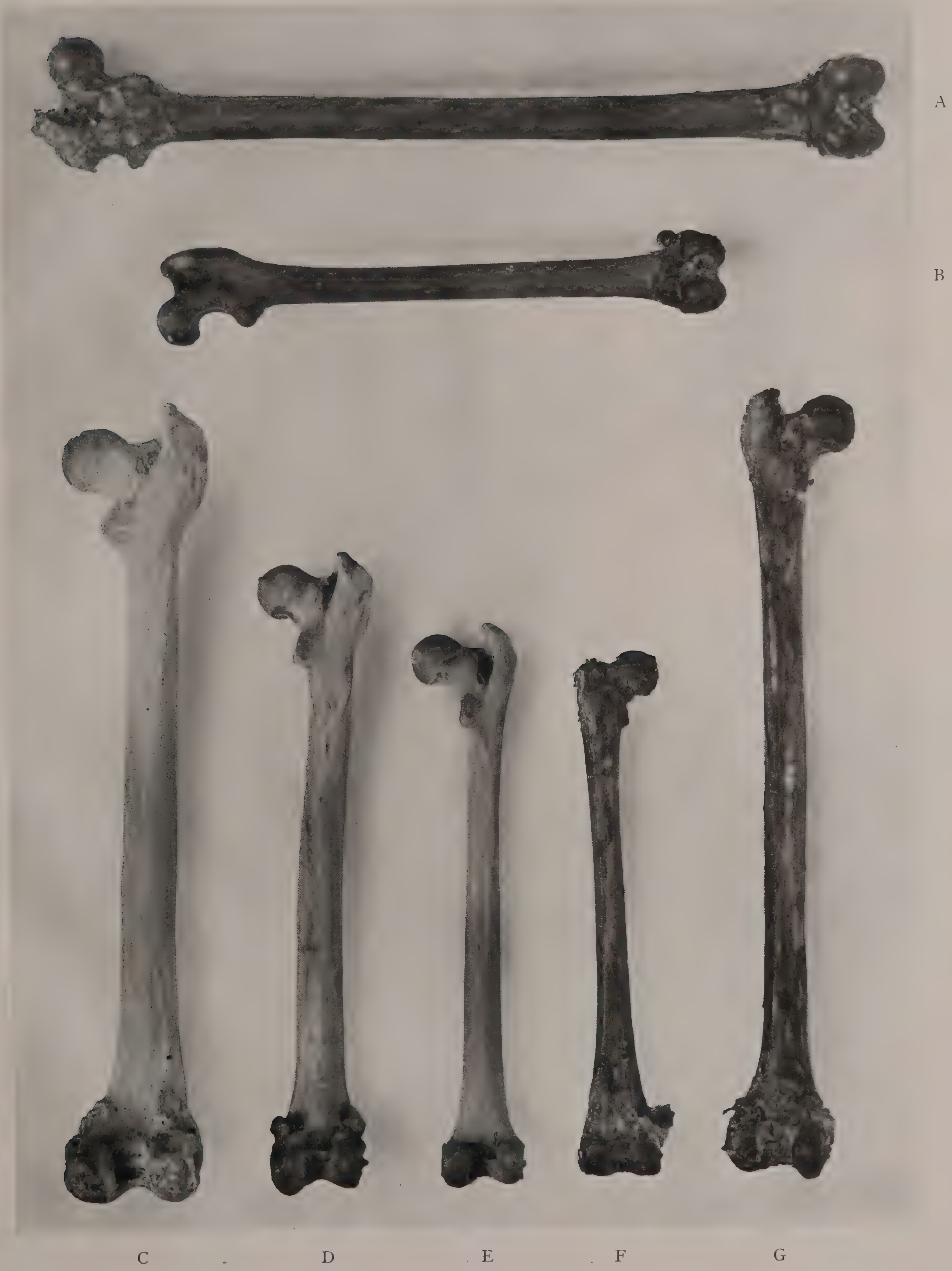
Anterior aspect of femora of Simiadae (A, B, C) and Cebidae (D, E). A. *Macacus speciosus* (Japanese ape). B, *Macacus inuus* (Barbary ape). C, *Cercopithecus lalandii.* D, *Midas ursulus* II. E, *Midas midas* II. Natural size.



Posterior aspect of femora of Simiadae (A, B, C) and Cebidae (D, E). A, *Macacus speciosus* (Japanese ape). B, *Macacus inuus* (Barbary ape). C, *Cercopithecus lalandii.* D, *Midas ursulus* II. E, *Midas midas* II. Natural size.

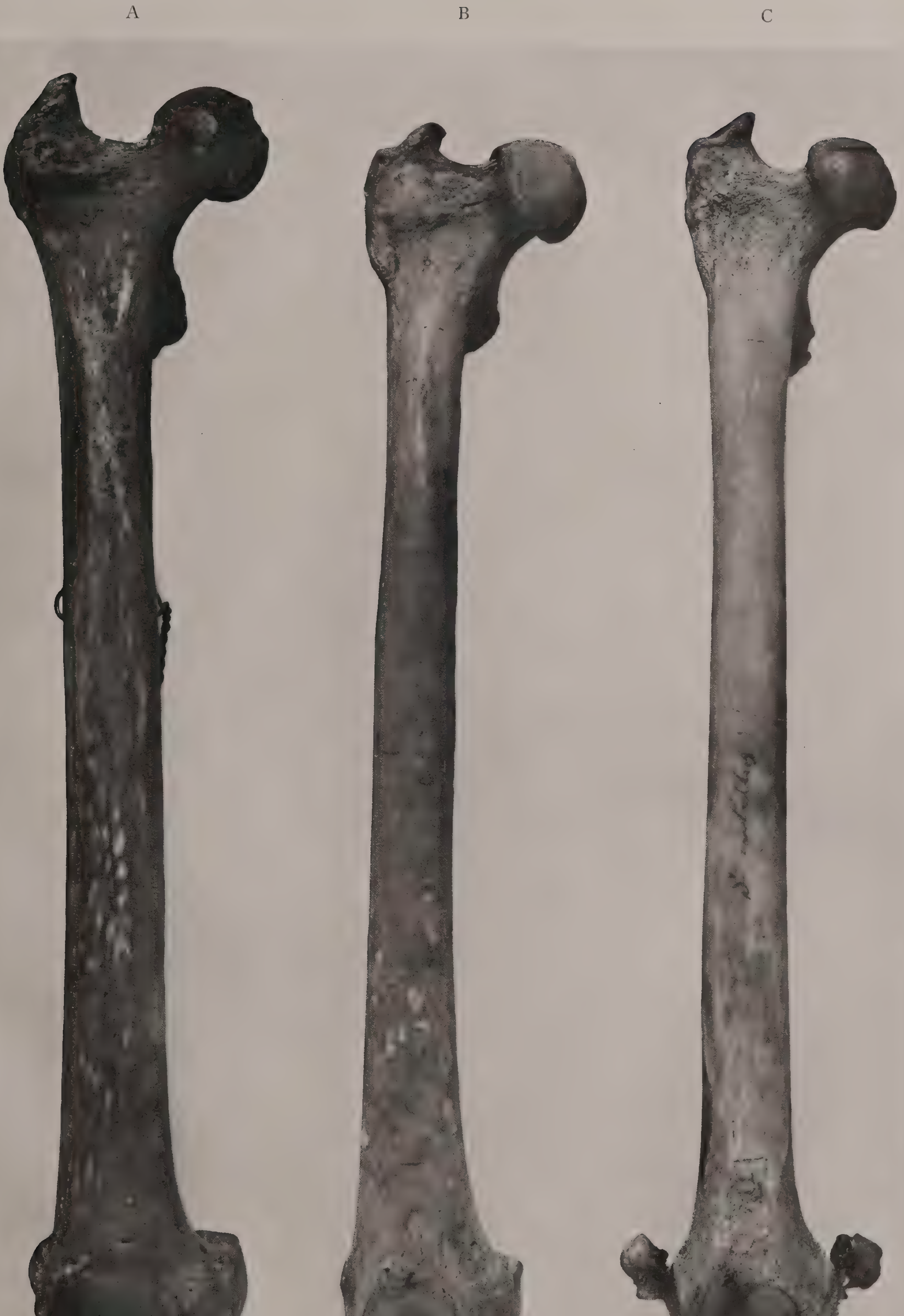


Anterior aspect of femora of Lemuroidea (A, B) and Simiadae (C, D, E, F, G). A, *Propithecus deckeni.* B, *Chiromys* (Aye-aye). C, *Cercopithecus pousarquei.* D, *Cercopithecus* —? E, *Cercopithecus callitrichus.* F, *Semnopithecus* —? G, *Semnopithecus frontalis.* Natural size.

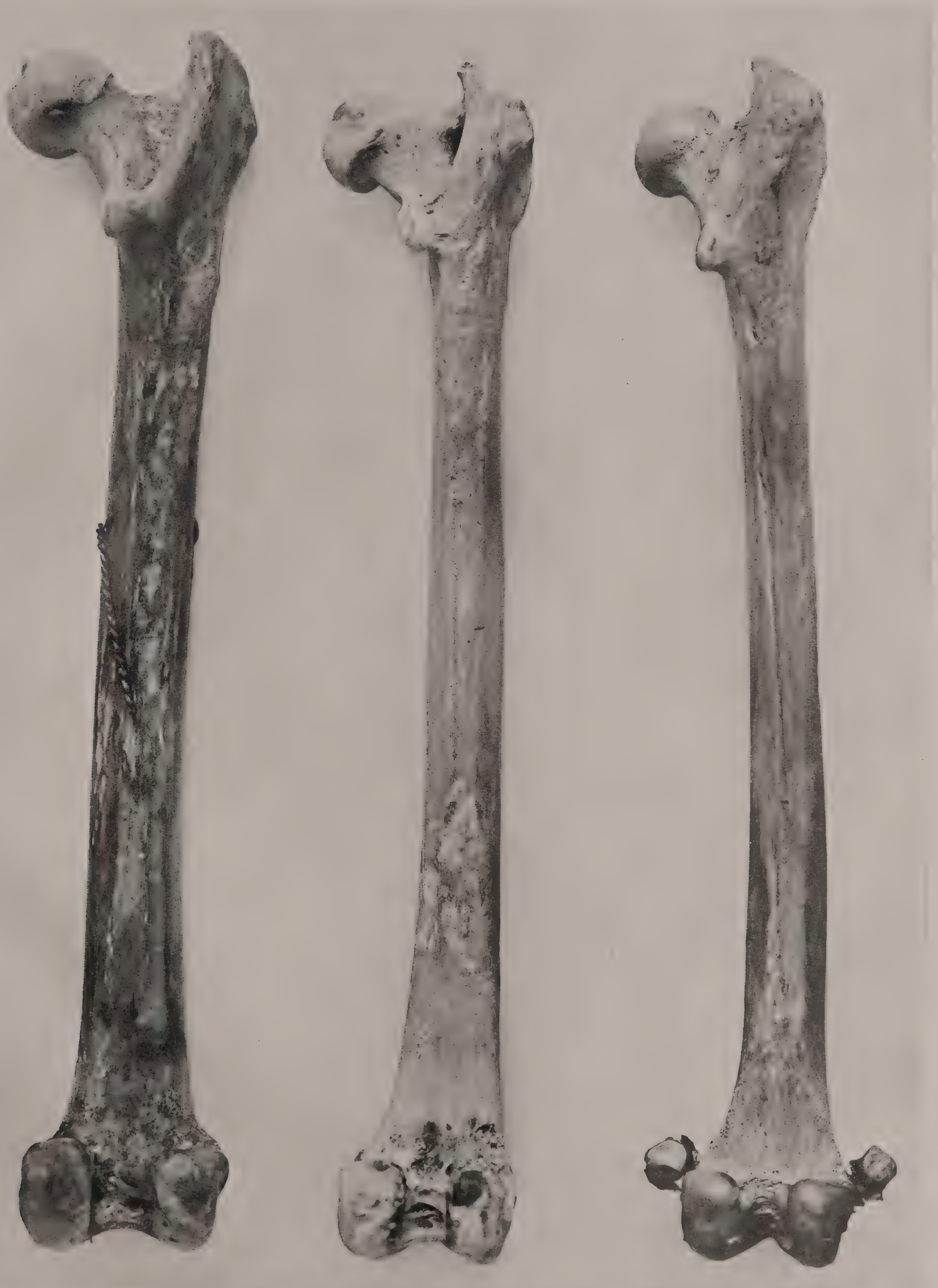


Posterior aspect of femora of Lemuroidea (A, B) and Simiadae (C, D, E, F, G). A, *Propithecus deckeni.* B, *Chiromys* (Aye-aye). C, *Cercopithecus pousarquei.* D, *Cercopithecus* —? E, *Cercopithecus callitrichus.* F, *Semnopithecus* —? G, *Semnopithecus frontalis.* Natural size.

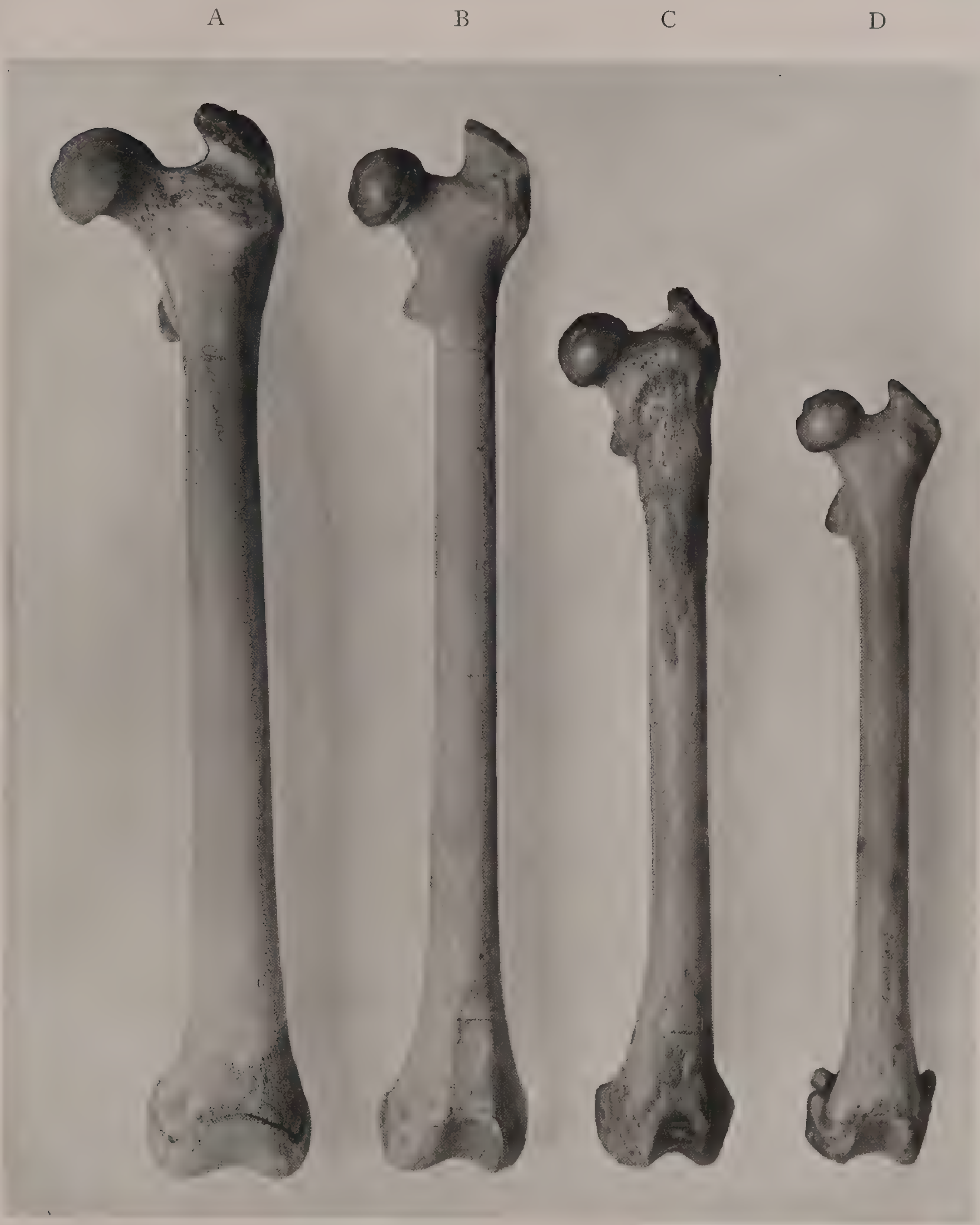
Plate LXXXIV



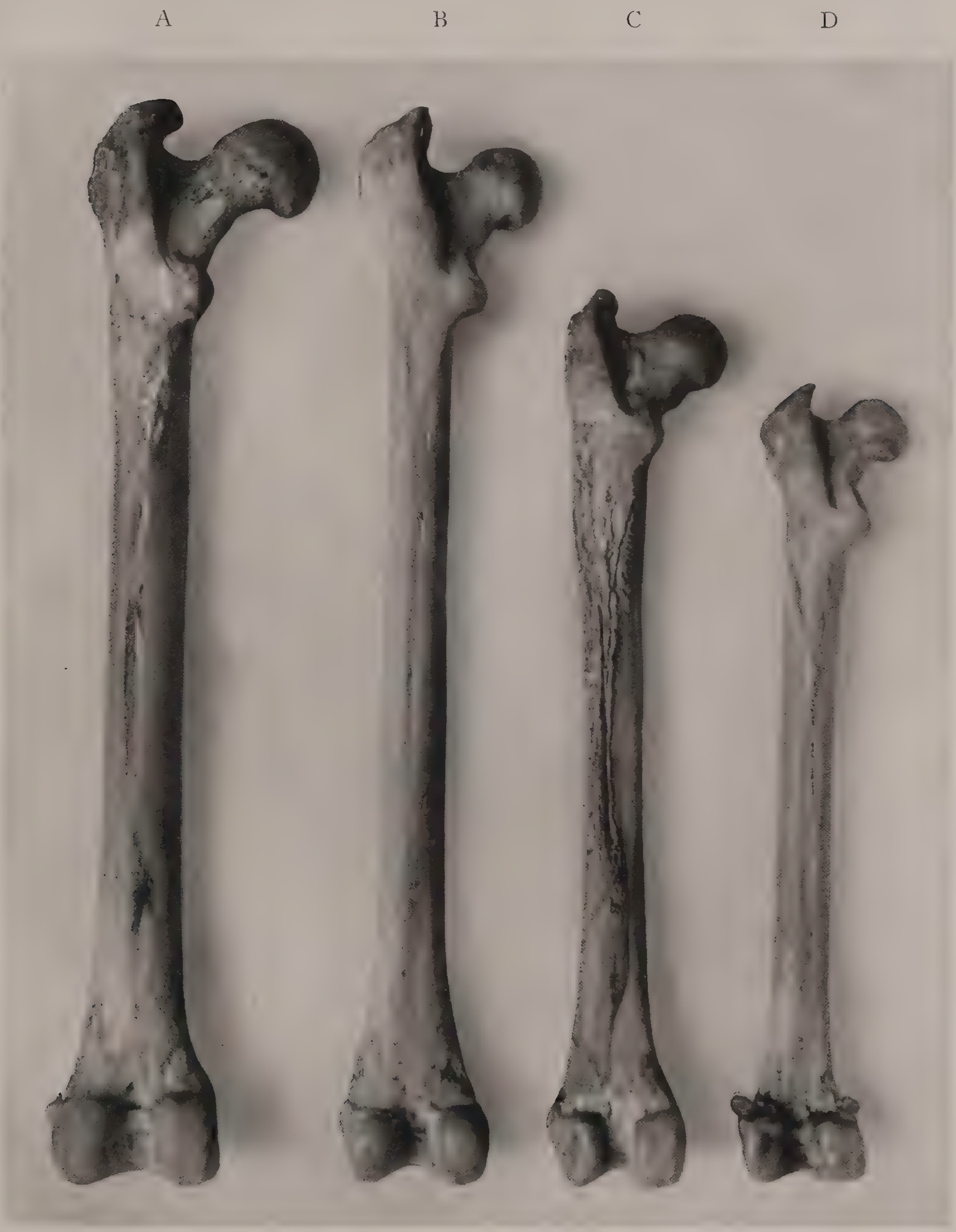
Anterior aspect of femora of the Simiadae. A, *Papio maimon*. B, *Nasalis larvatus*. C, *Semnopithecus entellus*. Natural size.



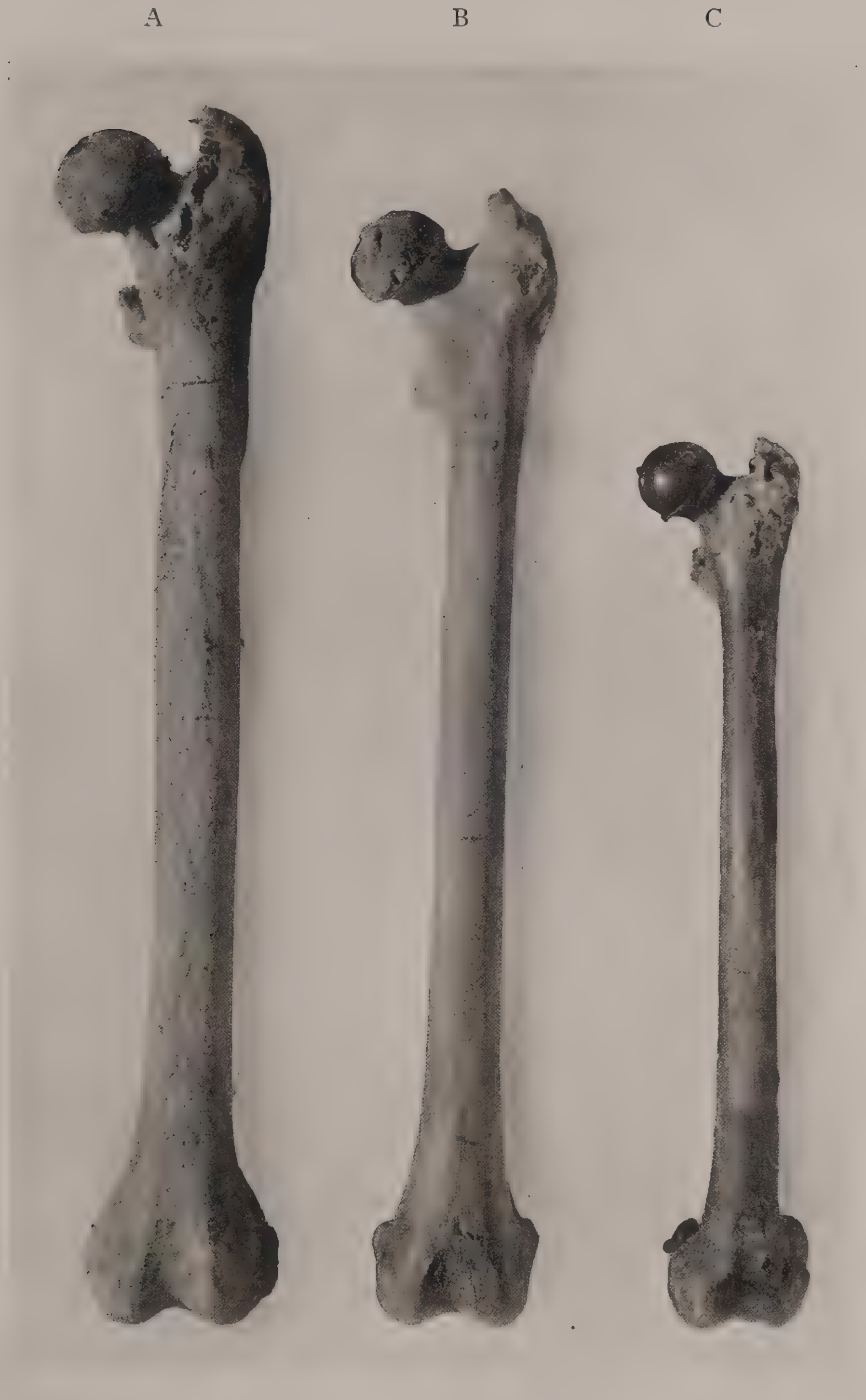
POSTERIOR ASPECT OF FEMORA OF THE SIMIADAE. A, *PAPIO MAIMON*. B, *NASALIS LARVATUS*. C, *SEMNOPITHECUS ENTELLUS*. NATURAL SIZE.



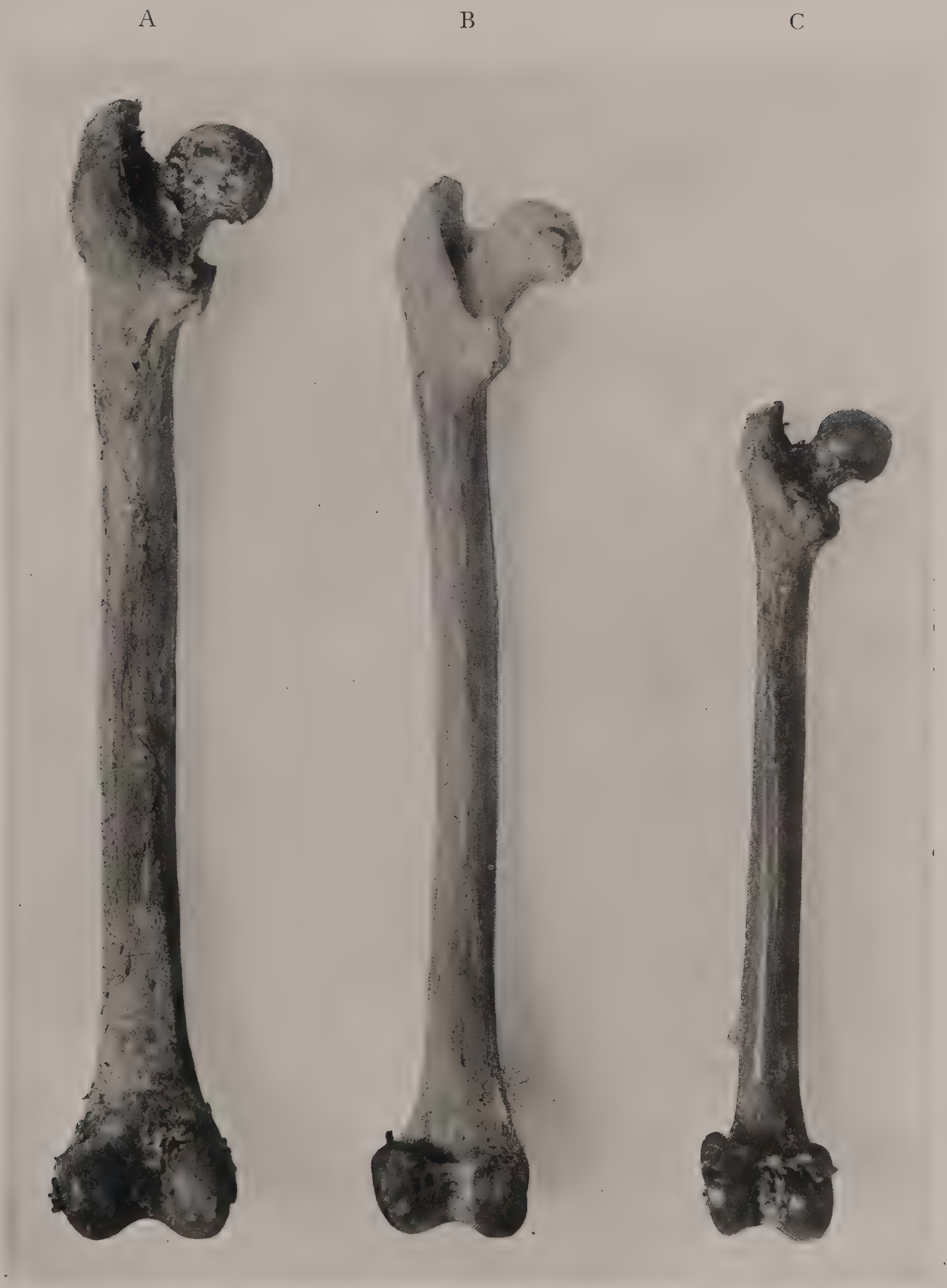
Anterior aspect of femora of the Simiadae. A, *Papio porcarius* (Chacma). B, *Papio hamadryas.* C, *Macacus nemestrinus.* D, *Macacus rhesus.* $\frac{2}{3}$ natural size.



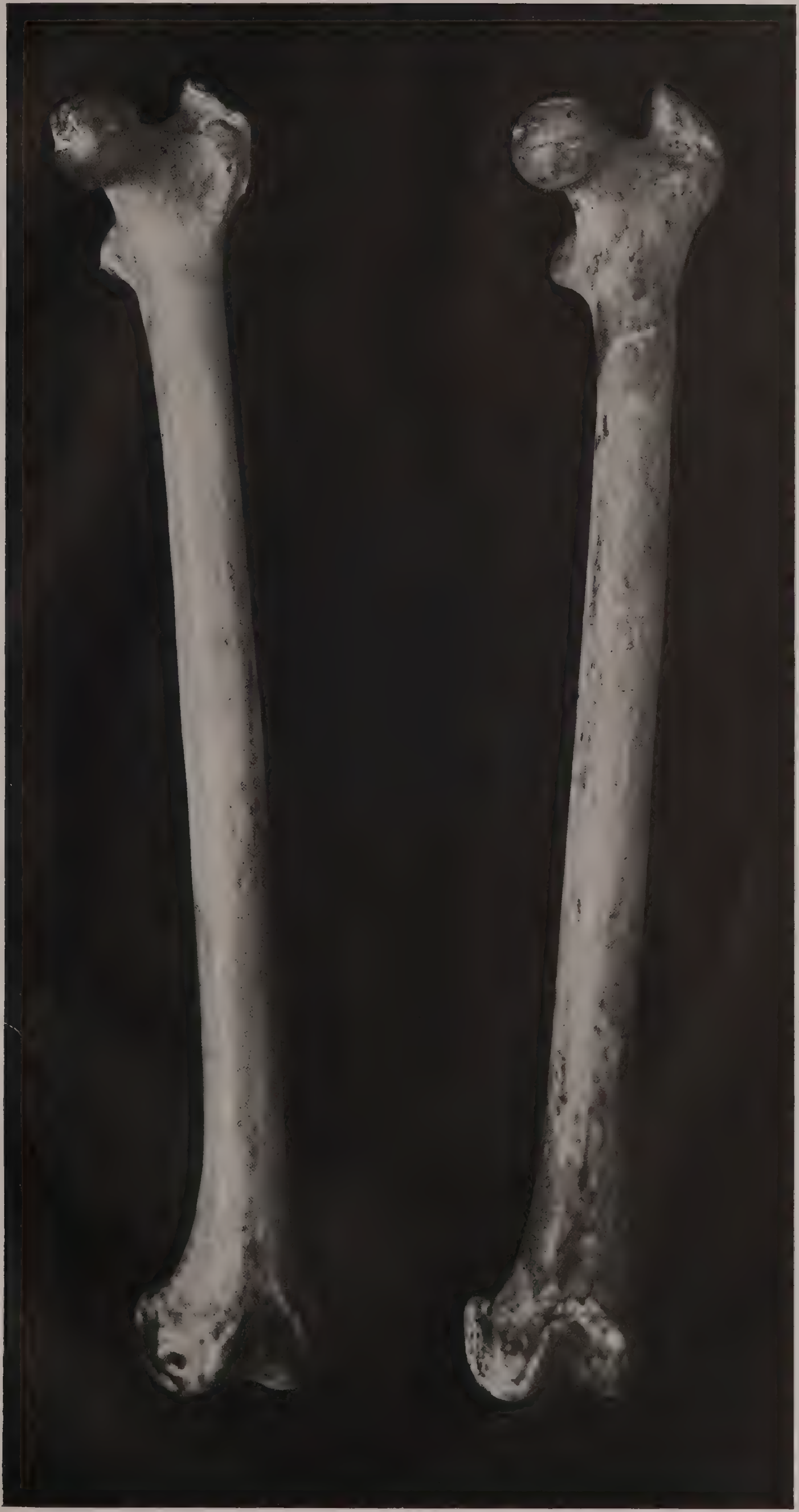
Posterior aspect of femora of the Simiadae. A, *Papio porcarius* (Chacma). B, *Papio hamadryas*. C, *Macacus nemestrinus*. D, *Macacus rhesus*. $\frac{2}{3}$ natural size.



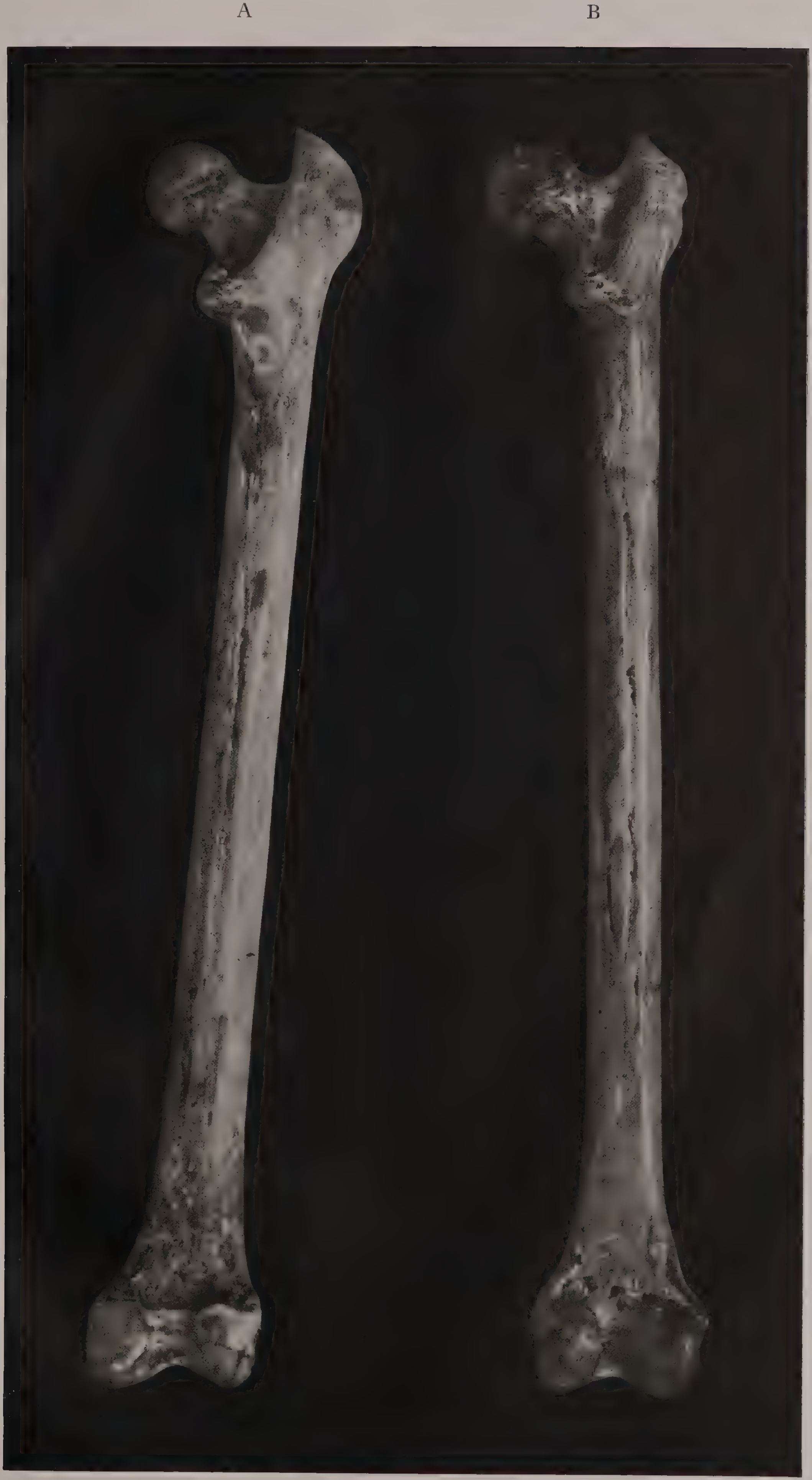
Anterior aspect of femora of the Simiadae. A, *Cynopithecus niger*. B, *Macacus cynomolgus* I. C, *Macacus cynomolgus* II. Natural size.



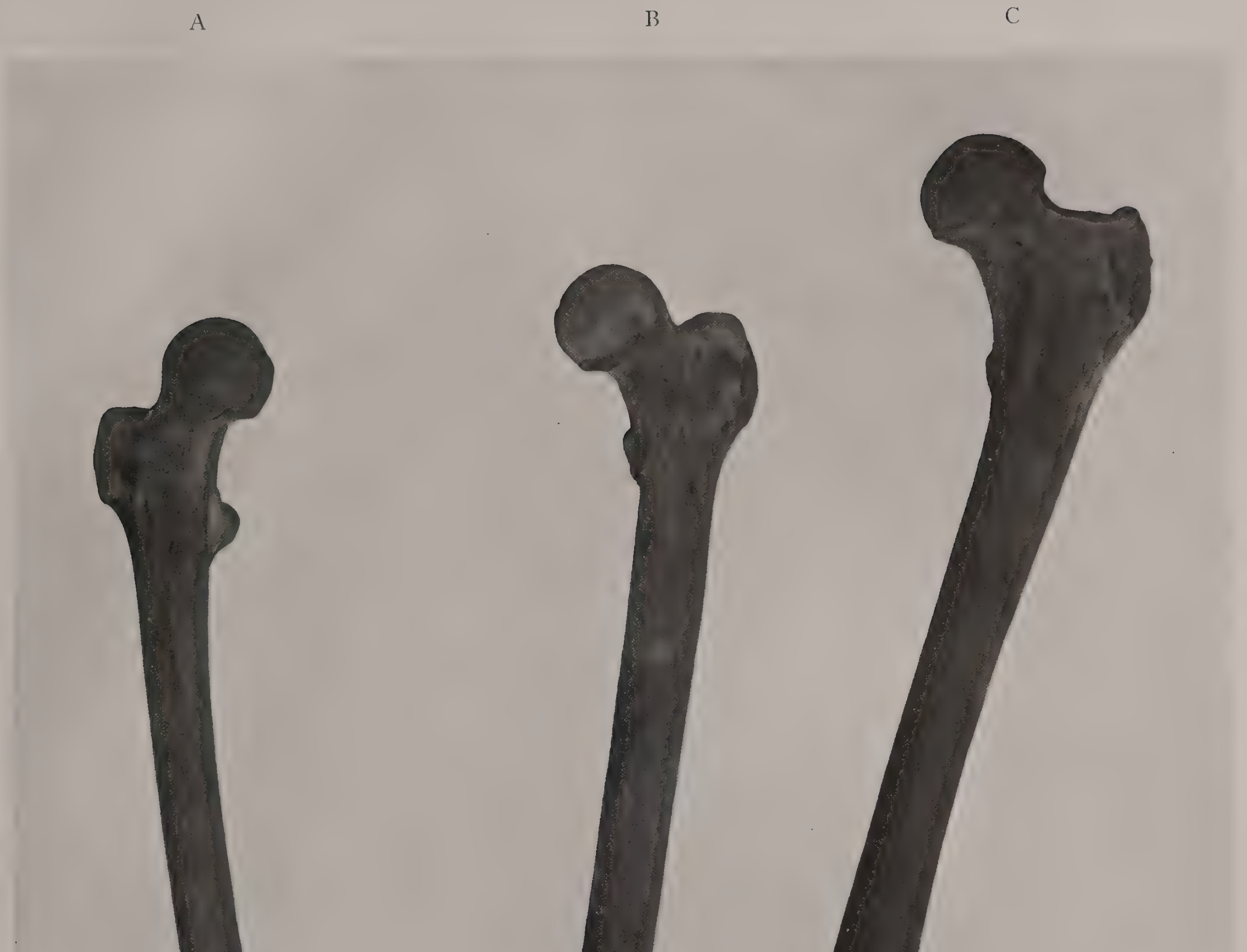
Posterior aspect of femora of the Simiadae. A, *Cynopithecus niger.* B, *Macacus cynomolgus* I. C, *Macacus cynomolgus* II. Natural size.



Anterior aspect of femora of the Simiadae. A, *Cercocebus aterrimus*. B, *Cercocebus albigena*. Natural size.

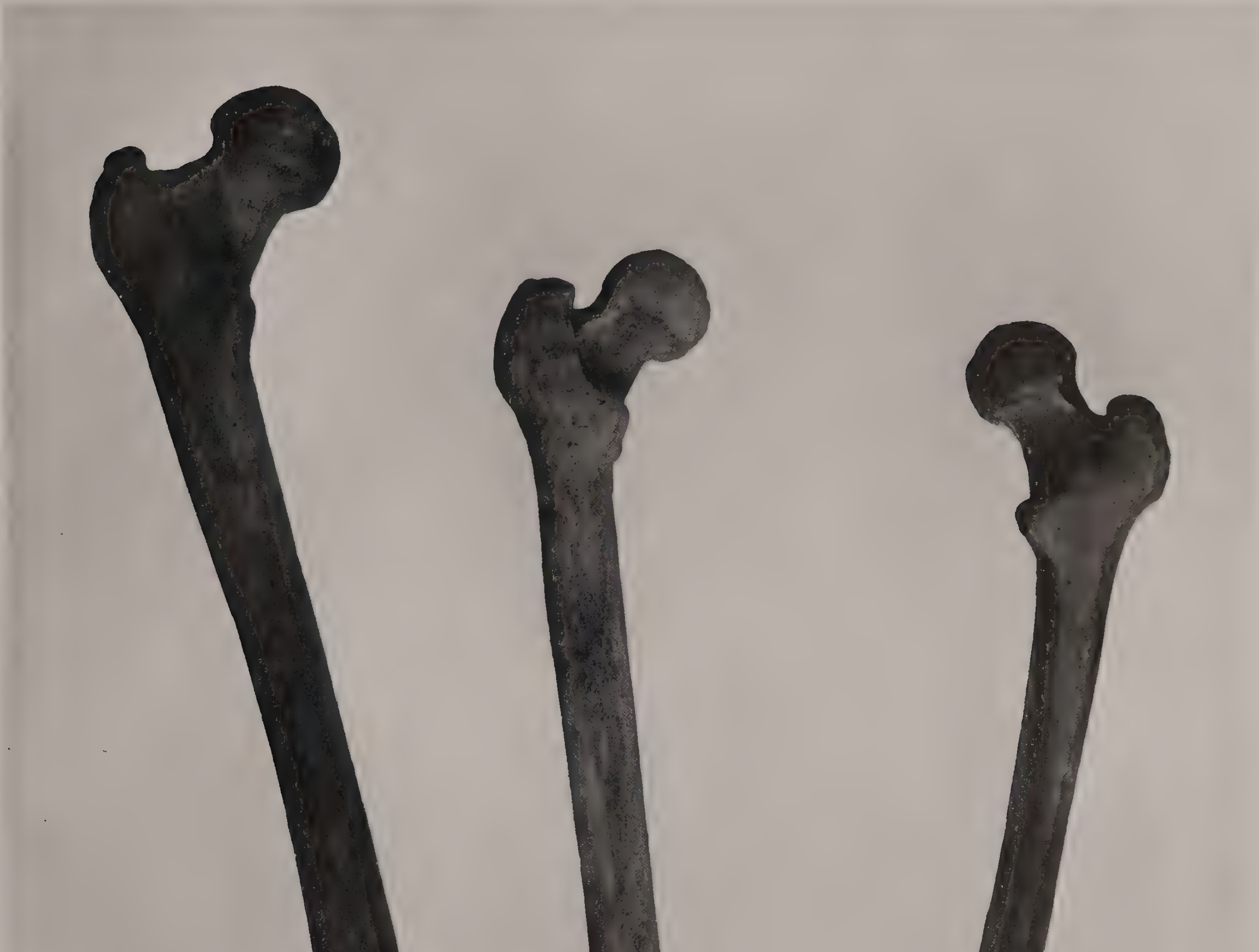


Posterior aspect of femora of the Simiadae. A, *Cercocebus albigena*. B, *Cercocebus aterrimus*. Note the existence of the Posterior fossa in both cases. Natural size.

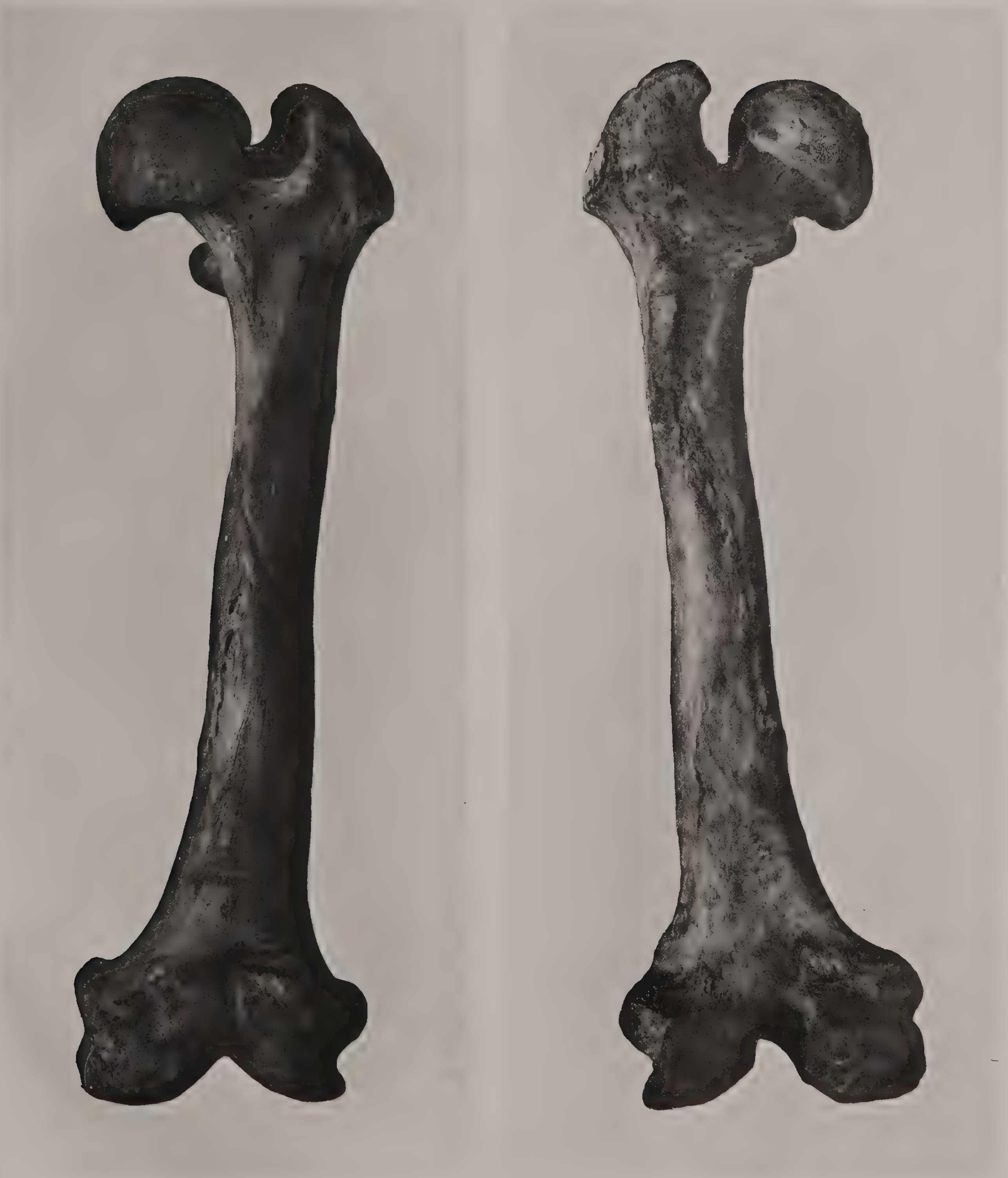


Anterior aspect of femora of Racial Dwarfs. A, Andaman. B and C, Bushmen. *Circa* ½ natural size.

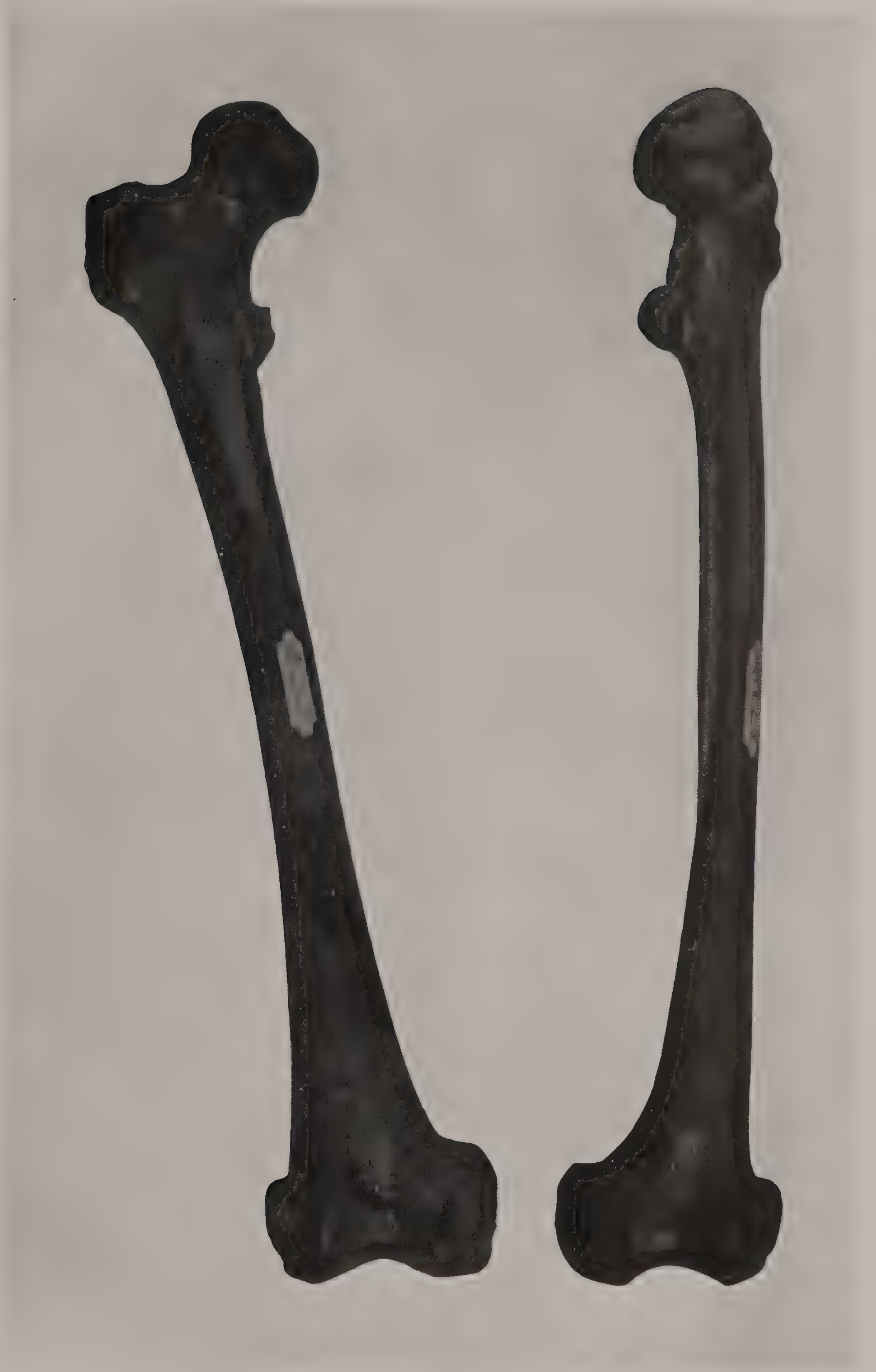
Plate XCIII



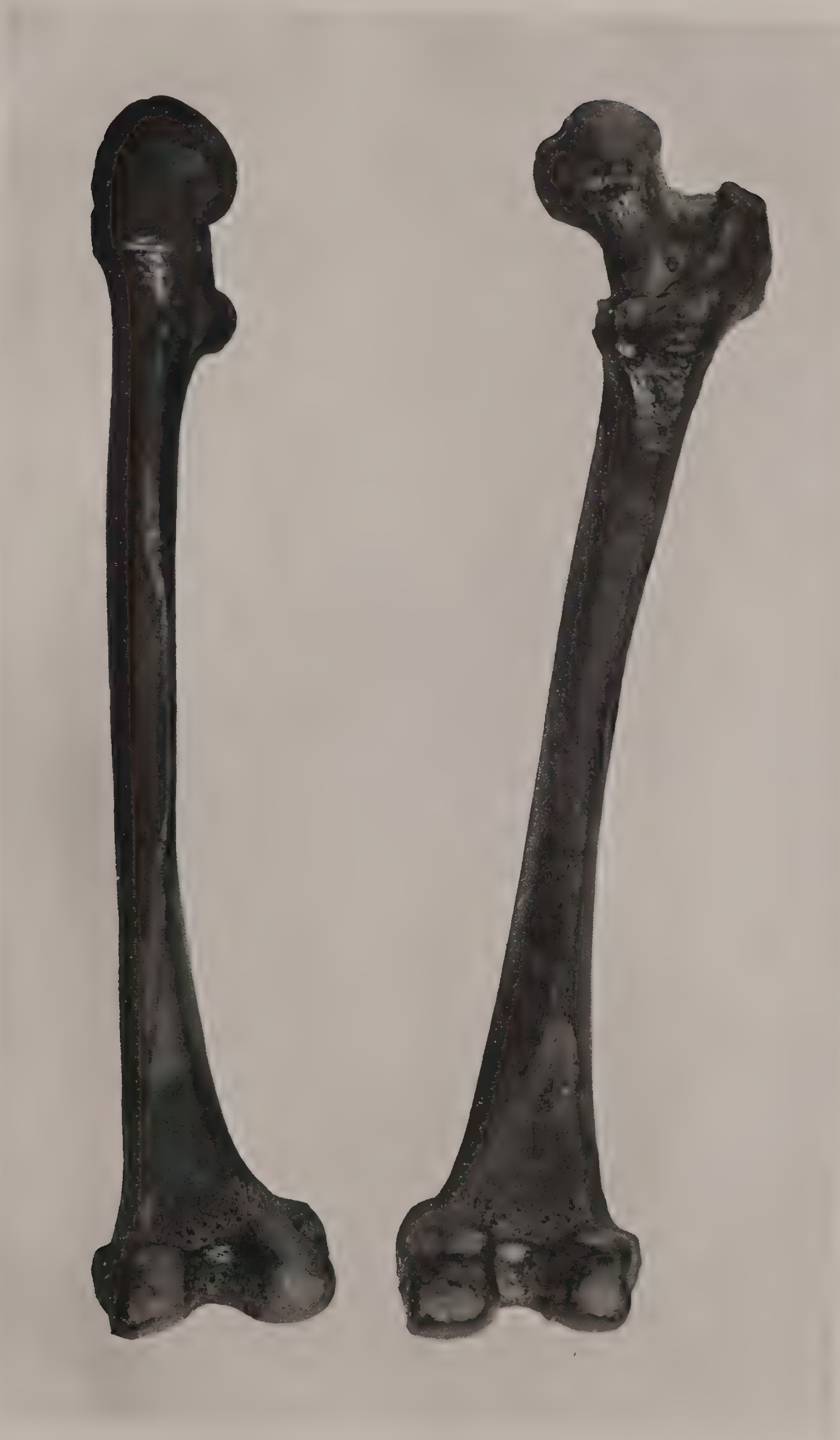
Posterior aspect of femora of Racial Dwarfs. A, Andaman. B and C, Bushmen. *Circa* ½ natural size.



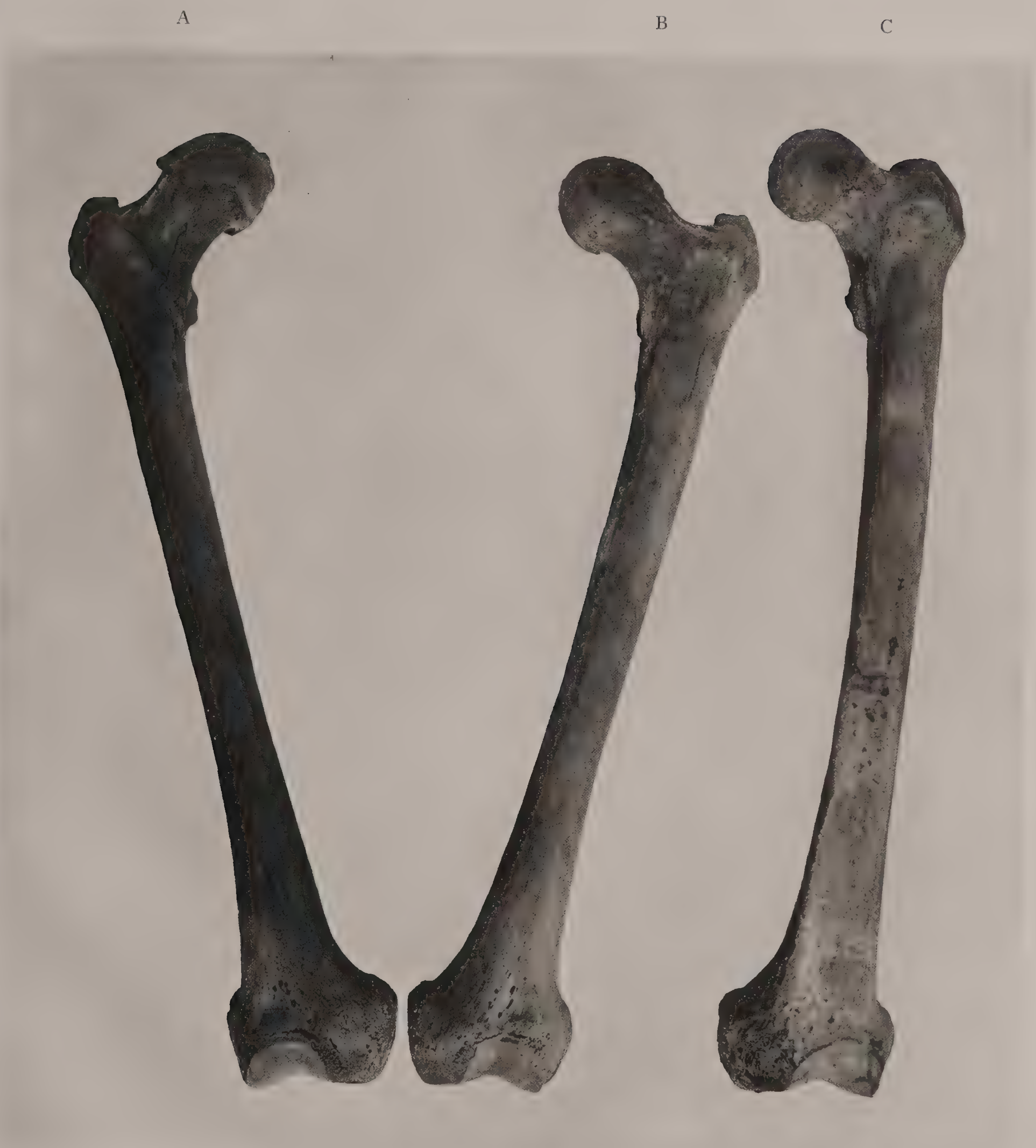
Anterior and posterior aspects of the L. femur of an Achondroplasic Dwarf, of Sudanese origin. Skeleton in the Royal College of Surgeons. This femur illustrates how pathological bones tend to exhibit reversionary characters. See Text, p. 442. ⅔ natural size.



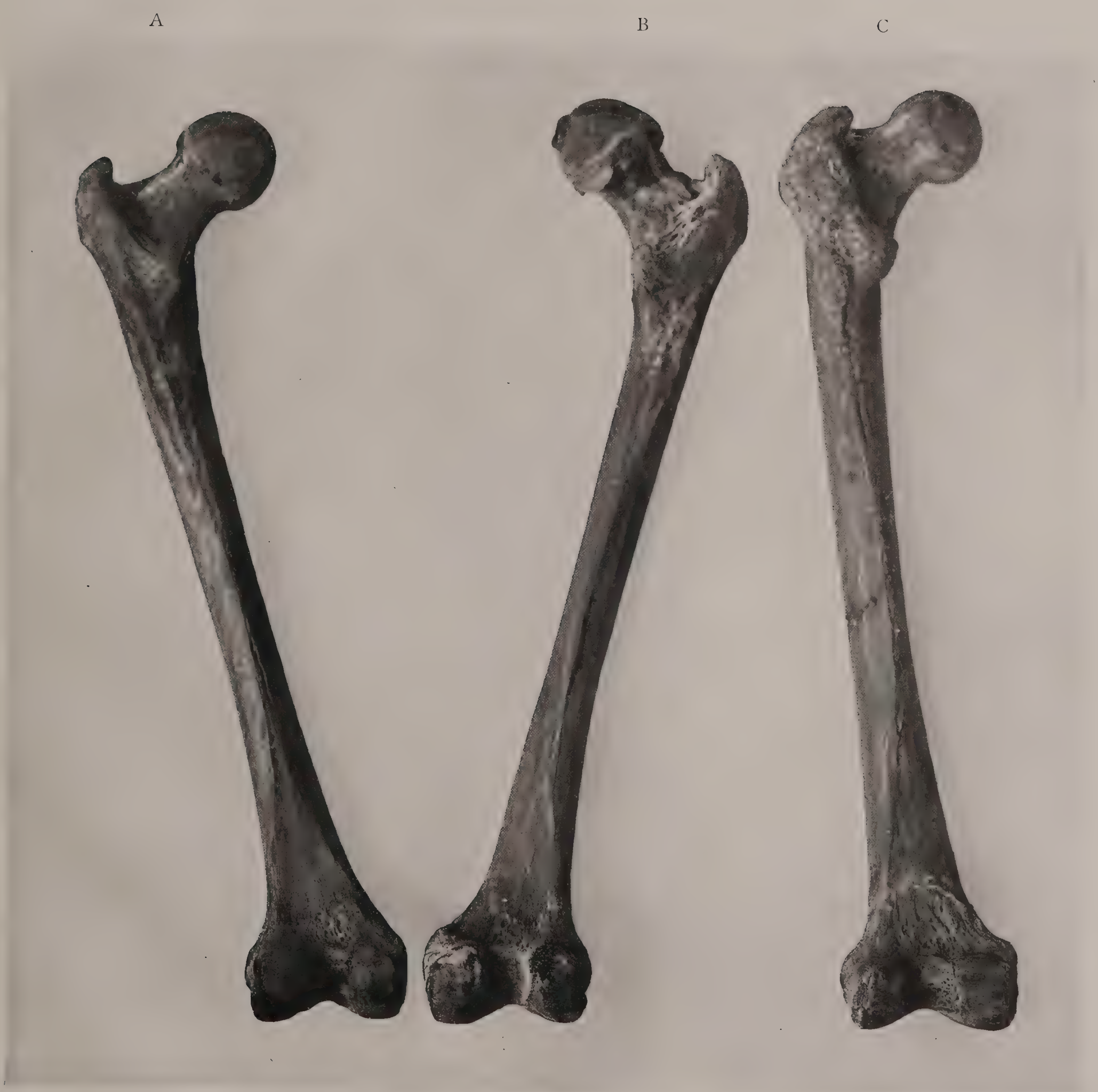
Anterior aspect of femora of Egyptian Dwarf of Roman Period in Museum of Royal College of Surgeons. Probably a case of ateleiosis, but accompanied by hemiplegia and partial paralysis of left side. Note the extreme torsion of left member and deformation of head. *Circa* $\frac{1}{2}$ natural size.



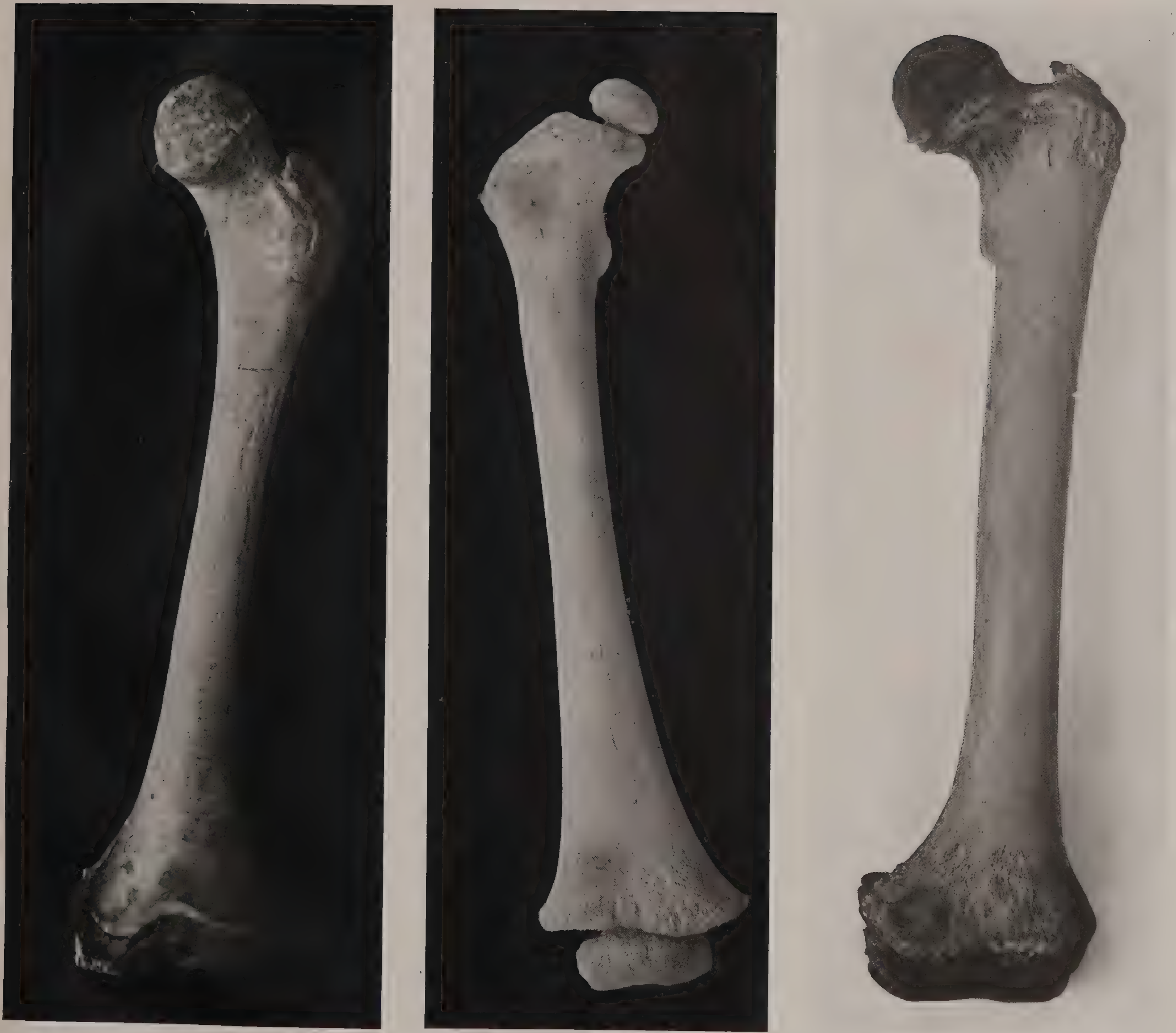
Posterior aspect of femora of Egyptian Dwarf in Museum of Royal College of Surgeons. Probably a case of ateleiosis, but accompanied by hemiplegia and partial paralysis of left side. (The bones are difficult to photograph as a red coloured preservative has been used.) *Circa* ½ natural size.



Australian femora, anterior aspect (A and B), compared with a very primitive human femur in Biometric Laboratory (C). Note the large lipped fovea of the latter and the great obliquity of all three. *Circa* $\frac{2}{5}$ natural size.



Types of Primitive femora. Posterior aspect. A and B, Australian femora. Note the marked obliquity in A and B, also the rim round the *fovea capitis* in B. C, Primitive femur of unknown origin. Note the horizontal character of the proximal face of the neck and the high value (97·7) of the Pithecoid Index in the latter. *Circa* $\frac{2}{5}$ natural size.

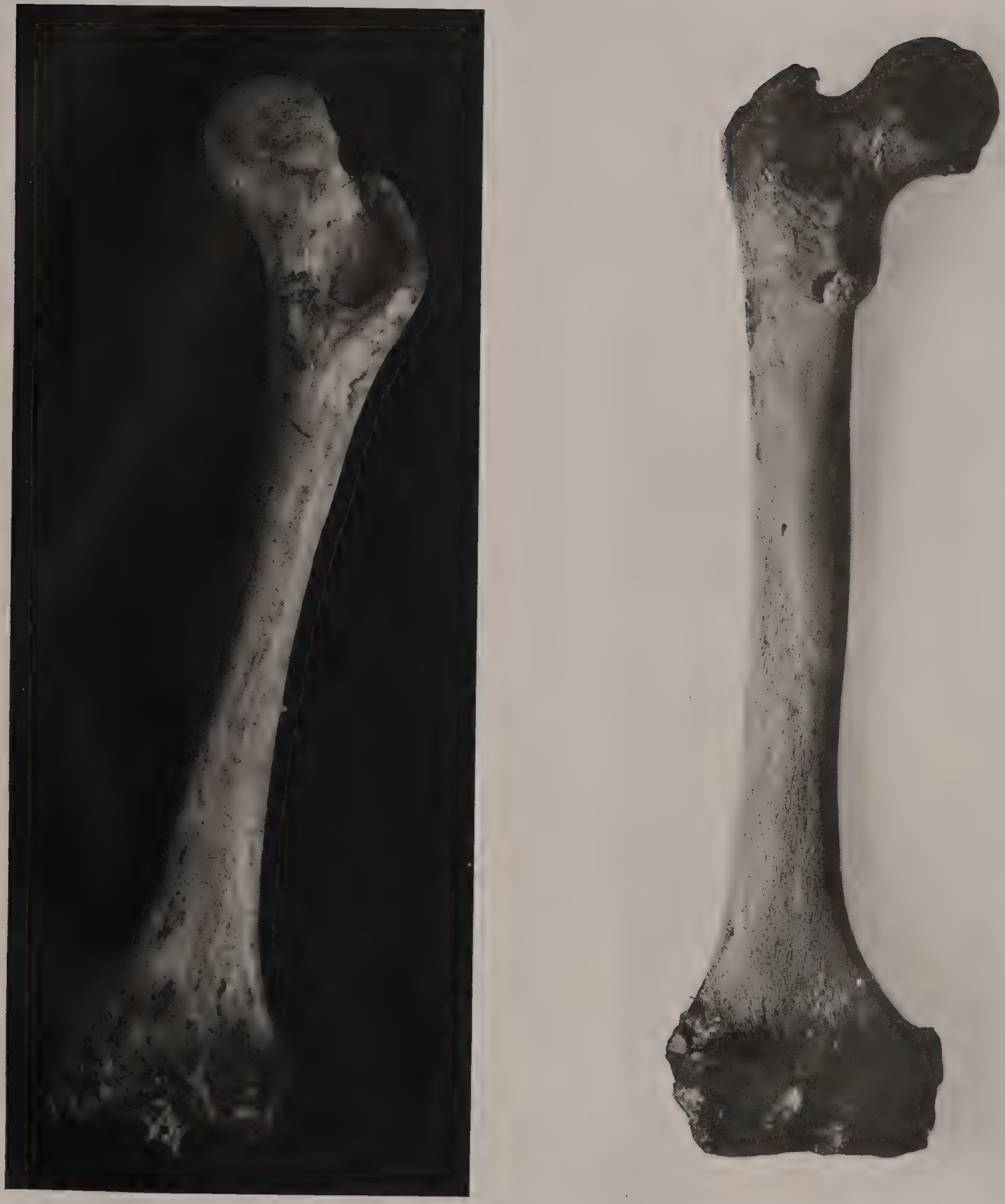


Infant Orang-utan.
Anterior aspect.

Infant Man (15 months).
Anterior aspect.

Infant Chimpanzee.
Anterior aspect.

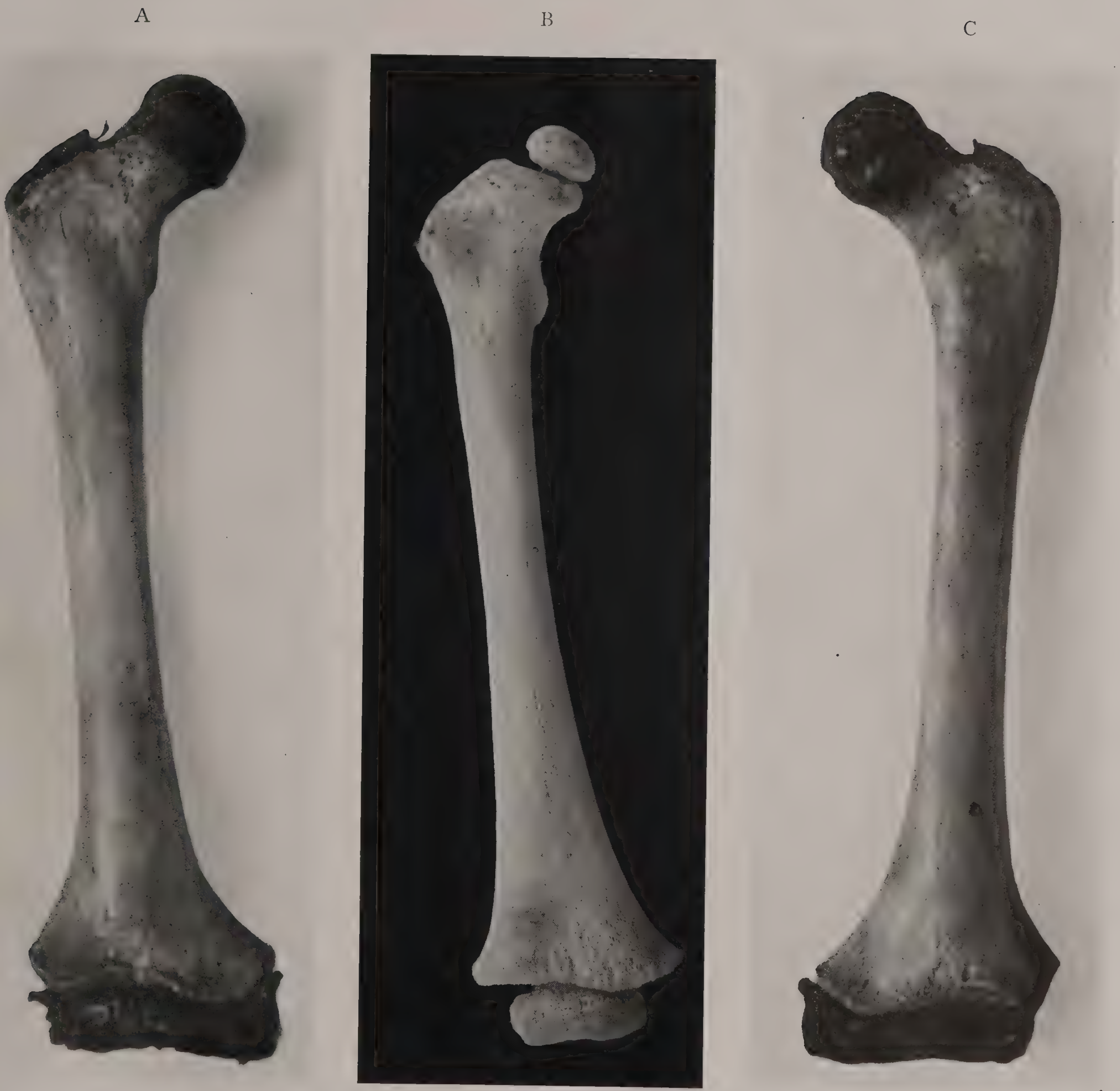
Comparison of femora of Infant Man with Infant Orang-utan and Infant Chimpanzee. Infant Man increased to approximately same size.



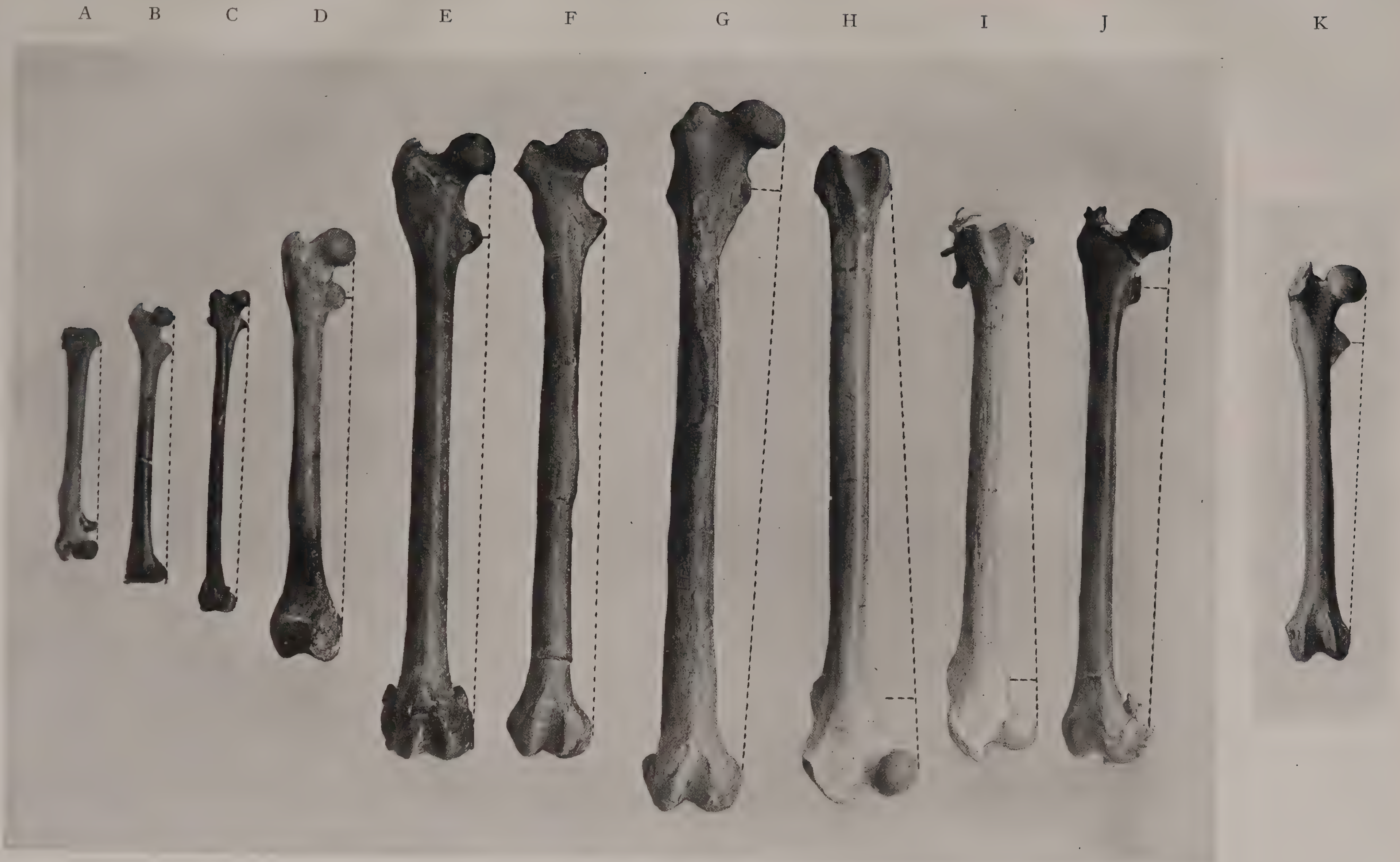
Infant Orang-utan.
Posterior aspect.

Infant Chimpanzee.
Posterior aspect.

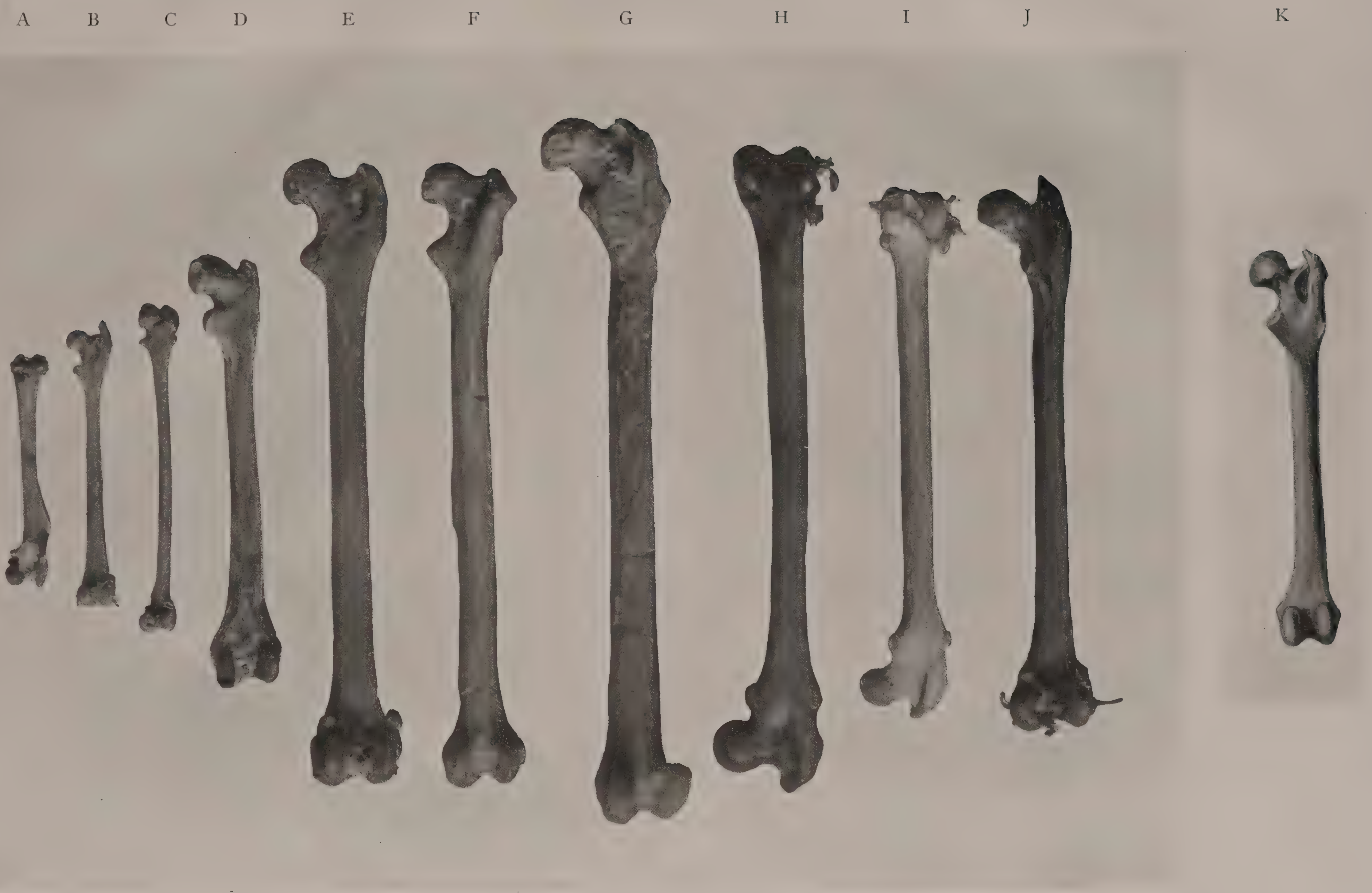
Comparison of femora of Infant Orang-utan and Infant Chimpanzee. Natural size.



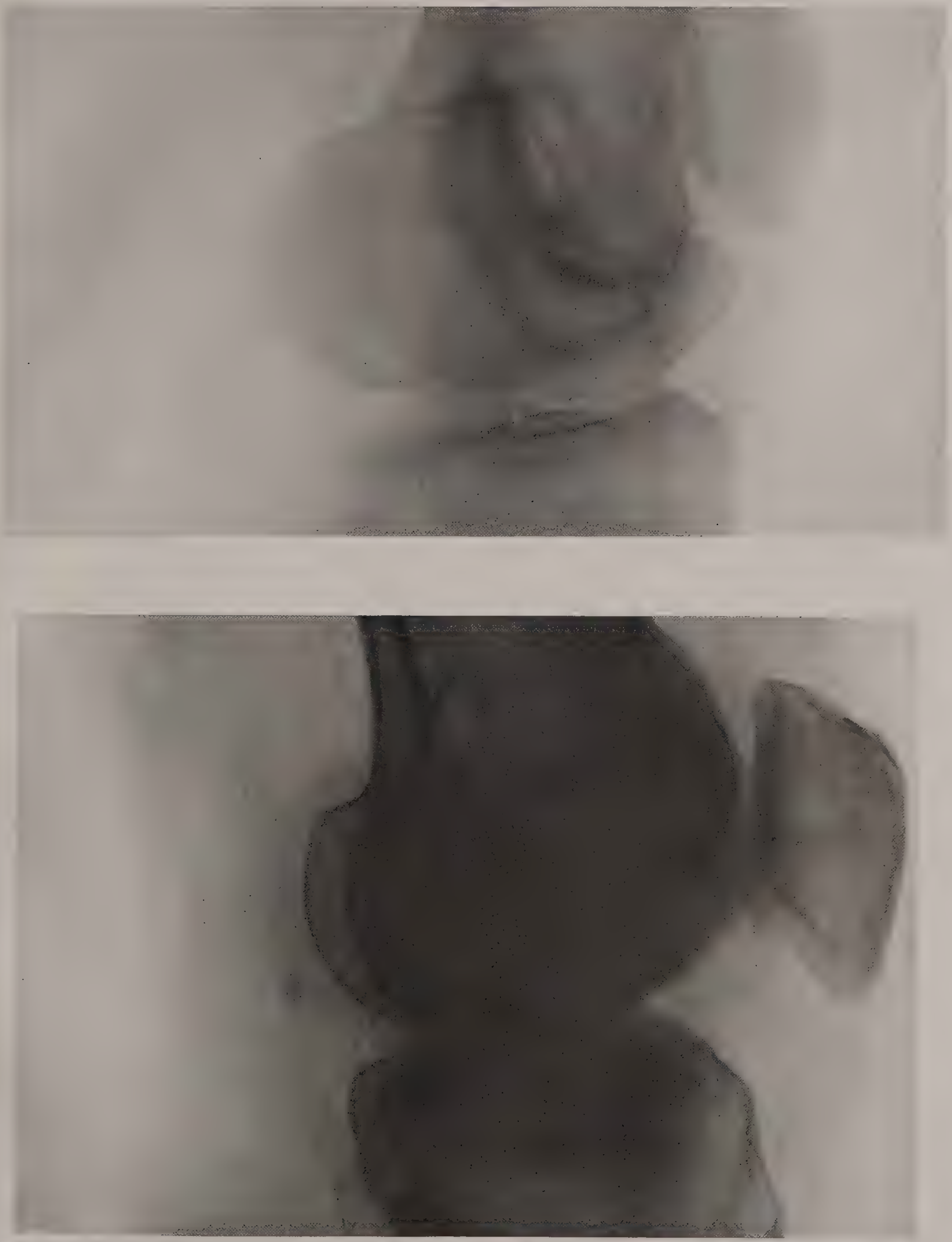
Comparison of the L. and R. femora of the Infant Gorilla (A and C) with that of Infant Man (B). Gorilla femora magnified to approximately same length as that of the child.



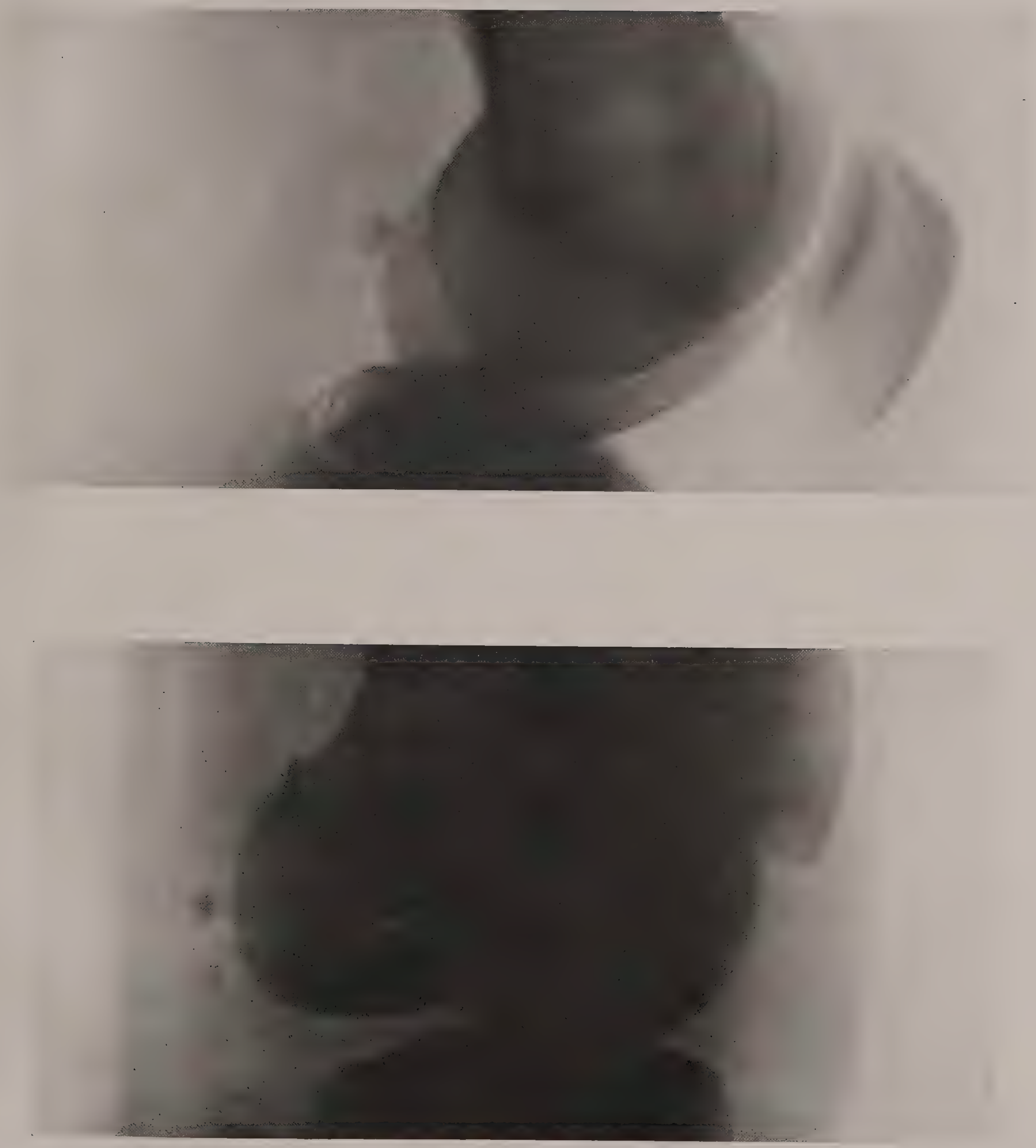
Fossil Lemuroids and Comparatives. Anterior aspect indicating the measurements taken to determine the Aspalacoid Index. F, *Notharctus osborni* and G, *Notharctus tenebrosus* from the Middle Eocene, Bridger Formation, U.S.A. K, *Adapis parisiensis* from European Eocene. A, *Tupaia chrysura*. B, *Jacchus*. C, *Tarsius spectrum*. D, *Perodicticus potto*. E, Aye-Aye. H, *Lemur rubriventer*. I, *Lemur catta*. J, *Cebus*.



Fossil Lemuroids and Comparatives. Posterior aspect. F, *Notharctus osborni* and G, *Notharctus tenebrosus* from the Middle Eocene, Bridger Formation, U.S.A. K, *Adapis parisiensis* from European Eocene. A, *Tupaia chrysura.* B, *Jacchus.* C, *Tarsius spectrum.* D, *Perodicticus potto.* E, Aye-Aye. H, *Lemur rubriventer.* I, *Lemur catta.* J, *Cebus.*



Skiagrams of Sesamoids in the case of Man. Lateral *Fabellae* in *M. gastrocnemius.* Note how low the sesamoid is as compared with its usual position in lower forms. Through the kindness of Captain S. Melville, R.A.M.C.



Skiagrams of Sesamoids in the case of Man. Lateral *Fabellae* in *M. gastrocnemius*. Note how low the sesamoid is as compared with its usual position in lower forms. Through the kindness of Captain S. Melville, R.A.M.C.

Measurements of Femoral Characters of the Primates (Man, Anthropoids, Lesser Apes and Lemuroids). TABLE I.

Family	Sub-family	Genus	Species	Characters	Maximum Length	Trochanteric Length	Max. Trochanteric Length	Oblique Length	Trochanteric Oblique Length	Capito-Trochlear Length	Diaphysial Length
HOMINIDAE	Homo sapiens	Recent Man	17th century Londoners ♂ ...		447·24	425·81	434·60	444·92	423·50	432·27	378·14
	,,	,,	,, ,, ♀		409·19	389·10	397·77	405·82	385·71	394·01	347·02
	,,	Primogenial Man	Neanderthal Type		423·0	406·5	412·6	419·6	405·6	395·7	354·0
ANTHROPOIDEA	Simiinae	Simia	S. satyrus (Orang)	3 R + 2 L	236·7	219·2	224·8	235·7	218·5	227·8	182·2
	,,	Troglodytes	T. niger (Chimpanzee) ...	... R + L	314·55	311·0	313·35	311·85	311·85	303·65	261·8
	,,	,,	T. gorilla ♂	3 R + 1 L	368·35	370·75	373·5	367·4	370·7	349·95	309·1
	,,	,,	,, ♀	3 R	309·0	304·9	305·8	307·2	304·5	297·9	253·0
	(Hylobatinae)	Hylobates	H. mülleri	2 R	193·55	192·2	193·1	193·5	192·15	187·4	170·7
SIMIIDAE	Semnopithecinae	Semnopithecus	S. —?	... R + L	115·4	113·2	114·0	115·4	113·3	109·3	101·7
	,,	,,	S. frontalis	... R + L	169·85	171·15	171·4	169·85	171·1	162·6	150·75
	,,	,,	S. entellus (Hanuman Monkey)	... R + L	249·0	254·5	254·25	245·95	254·4	238·05	214·6
	,,	,,	Nasalis larvatus (Proboscis Monkey)	R + L	247·75	252·15	252·35	246·3	252·05	237·8	214·95
	,,	Colobus	Colobus satanas	... R + L	229·05	228·5	228·75	226·5	228·0	219·35	200·5
	Cynopithecinae	Cercopithecus	C. callitrichus	... R + L	120·5	122·85	123·35	120·5	122·9	114·2	104·9
	,,	,,	C. —?	R	137·0	138·0	140·0	137·0	138·0	129·4	120·4
	,,	,,	C. lalandii	... R + L	142·8	142·55	142·8	142·4	142·35	136·55	122·2
	,,	,,	C. pousarquei	R	168·0	172·5	174·0	168·0	172·5	160·0	146·0
	,,	,,	C. pousarquei†	L	?	?	173·2	?	?	159·1	144·0
	,,	(Cercocebus)	C. aterrimus	... R + L	221·2	222·7	222·0	218·8	221·4	213·1	190·7
	,,	,,	C. albigena	... R + L	[illegible]	223·6	222·2	[illegible]	[illegible]	[illegible]	192·5
	,,	Macacus	M. nemestrinus	... R + L	202·75	208·75	209·25	202·75	208·75	193·25	181·25
	,,	,,	M. rhesus I	... R + L	184·5	187·75	188·0	184·25	187·75	177·2	161·65
	,,	,,	M. rhesus II	... R + L	185·25	187·25	187·75	184·6	186·75	176·85	157·05
	,,	,,	M. cynomolgus I	... R + L	157·5	161·0	161·0	157·5	161·0	152·9	136·4
	,,	,,	,, II	... R + L	126·45	126·2	126·9	126·45	126·1	120·8	109·85
	,,	,,	M. inuus (Barbary Ape) ...	... R + L	180·3	180·85	181·3	179·3	180·95	171·4	152·2
	,,	,,	M. speciosus† (Japanese Ape) ...	R	176·1	176·4	176·9	175·2	176·3	166·8	147·0
				L	[167·9]	[167·2]	[167·4]	[166·8]	[167·1]	[160·8]	[138·2]
	,,	Cynocephalus	Cynopithecus niger	... R + L	[illegible]	173·35	173·0	[illegible]	173·35	[illegible]	149·05
	,,	,,	Cynocephalus hamadryas ...	... R + L	242·0	250·0	250·0	242·0	250·0	233·5	215·5
	,,	,,	Cynocephalus porcarius (Chacma)	R + L	247·0	253·5	253·25	247·0	253·0	240·3	219·5?
	,,	,,	Papio maimon	... R + L	257·05	260·0	260·9	254·45	260·0	244·65	212·4
CEBIDAE	Cebinae	Ateles	A. ater	... R + L	215·4	214·4	215·5	215·4	214·4	205·6	186·1
	,,	,,	A. paniscus	... R + L	231·65	221·75	223·5	231·25	221·5	223·15	196·25
	,,	Eriodes	No skeleton available								
	,,	Lagothrix	L. Humboldtii	... R + L	112·0	110·0	109·5	111·5	109·5	105·4	94·7
	,,	Cebus	C. flavius	... R + L	119·75	119·55	120·75	119·25	118·7	111·8	104·1
	,,	,,	C. —?	... R + L	108·55	108·25	108·95	108·5	108·05	103·85	94·4
	,,	,,	C. capuchinus	... R + L	130·3	129·7	130·2	103·3	129·65	124·7	112·5
	Mycetinae	Mycetes	M. palliatus	... R + L	151·65	148·75	149·5	151·55	148·7	142·9	130·65
	Pithecinae	Pithecia	P. monarchia (Saki Monkey)	... R + L	129·6	127·3	128·05	129·3	126·85	124·9	115·05
	,,	Brachyurus	B. rubicundus (Redfaced Ouakari)	R + L	155·2	153·9	154·25	154·85	153·85	150·95	137·15
	Nyctipithecinae	Nyctipithecus	N. lemurinus	... R + L	76·35	75·7	76·0	76·1	75·55	72·25	66·0
	,,	Chrysothrix	C. sciurea I	... R + L	87·45	87·2	87·3	87·45	87·2	83·25	77·55
	,,	,,	,, II	... R + L	91·55	90·95	91·25	91·55	90·75	86·85	81·0
	,,	Callithrix	C. personatus	... R + L	99·75	97·6	97·85	98·5	97·05	95·5	86·75
	Hapalinae	Hapale	Hapale Jacchus	... R + L	56·95	56·75	57·0	56·9	56·85	53·85	49·5
	,,	,,	Jacchus —? I	... R + L	54·9	55·45	55·55	54·85	55·45	52·9	48·3
	,,	,,	Jacchus —? II	... R + L	83·0	82·85	83·2	83·0	82·8	80·25	70·35
	,,	,,	Jacchus auritus	... R + L	64·25	63·7	63·9	64·25	63·6	60·35	55·65
	,,	Midas	M. midas	... R + L	69·0	69·3	69·6	68·75	69·15	66·6	59·65
	,,	,,	M. auritus	... R + L	68·55	68·75	69·2	68·5	68·75	64·4	59·1
	,,	,,	M. ursulus I (Negro tamarin)	... R + L	63·6	64·35	64·3	63·45	64·3	60·6	55·1
	,,	,,	M. ursulus II	... R + L	66·65	66·6	66·25	66·25	66·0	61·4	[illegible]
LEMUROIDEA	Lemuridae	Indrisinae	Propithecus diadema ...	... R + L	187·0	191·0	190·0	186·0	190·5	180·0	168·0
	,,	,,	,, deckeni ...	... R + L	184·0	184·5	184·0	180·5	184·0	174·8	[illegible]
	,,	,,	,, coronatus ...	... R + L	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	,,	,,	Avahis laniger	... R + L	133·8	134·55	134·7	133·7	134·5	128·5	120·45
	,,	Lemurinae	L. rubiventer I	L	128·0	129·0	129·5	128·0	129·0	123·1	109·5
	,,	,,	,, II	L	125·0	129·0	130·0	125·0?	129·0	120·0	108·0
	,,	,,	L. macaco	... R + L	150·0	152·0	152·0	150·0	152·0	144·7	124·0
	,,	,,	L. niger	... R + L	134·0	138·0	137·5	134·0	137·6	130·2	116·9
	,,	,,	L. catta	... R + L	103·0	105·5	106·5	103·0	105·5	[illegible]	[illegible]
	,,	,,	L. melanocephalus (Mongoz)	... R + L	131·75	133·1	133·8	131·45	132·9	125·35	111·3
	,,	,,	L. macaco niger	... R + L	134·25	137·45	138·15	133·95	137·45	129·45	114·85
	,,	,,	L. macaco leucomystax ...	... R + L	135·1	138·0	138·2	134·8	139·6	128·0	116·8
	,,	,,	L. rufifrons	... R + L	119·0	122·3	122·55	118·3	122·3	113·35	103·5
	,,	,,	Hapalemur griseus	... R + L	86·25	88·85	89·75	86·0	88·85	82·95	75·05
	,,	Galaginae	Galago crassicaudatus ...	... R + L	80·4	79·7	80·05	80·4	79·6	75·85	65·1
	,,	,,	,, alleni	... R + L	73·5	72·65	72·8	73·45	72·75	70·65	63·8
	,,	,,	Chirogaleus	... R + L	29·6	30·05	30·3	29·35	[illegible]	28·95	25·6
	,,	Lorisinae	Loris gracilis	... R + L	67·0	66·6	67·05	66·85	66·35	[illegible]	58·1
	,,	,,	Nycticebus javanicus ...	... R + L	[illegible]	74·9	75·65	[illegible]	[illegible]	72·75	[illegible]
	,,	,,	Potto	... R + L	86·3	84·75	85·55	85·95	84·6	81·95	74·2
	Chiromyrdae	Chiromys	Chiromys (Aye-Aye) ...	... R + L	124·65	123·75	124·0	124·55	123·65	118·45	109·65
	Tarsudae	Tarsius	Tarsius spectrum	... R + L	64·2	63·9	64·1	64·1	63·85	61·75	55·5
	Pliocene Fossils	Simopithecus	S. oswaldi		[181·5?]	—	—	[181·5?]			[illegible]
	,,	Dryopithecus	D. rhenanus (Eppelsheimer femur)	L	287·0	284·2	285·0	286·3	284·6	279·9	255·9

† Left member pathological.

* See Remarks

§ Avoiding "4th" trochanter.

* See Remarks

Measurements and Descriptions of the Femoral Characters of the Primates (Man, Anthropoids, Lesser Apes and Lemuroids). TABLE II.

Family	Sub-family	Genus	Species ↓	Characters →	INDICES OF THE SHAFT															INDICES OF DISTAL EPIPHYSIS										REMARKS
					Platymeric Index	Pilastric Index	Popliteal Index	Index of Popliteal Skewness	Popliteal Pyramidal Index	Soffit Index	Index of Gracility (Upper)	Index of Gracility (Lower)	Index of Transverse Slenderness	Index of Sagittal Slenderness	Index of Proximal Taper	Index of Distal Taper	Popliteal Shaft Index	Primary Index of Bowing	Secondary Index of Bowing	Condylar Index	Condylar Lengths Index	Bicondylar Ratio	Band-radial Index	Condylar Trochanteric Index	Distal Articulation Ratio	Distal Articulation Index	Rotular Ratio	Rotular Index	Diaphysial Rotular Ratio	[In these remarks no abbreviations not readily interpretable are used except in the case of the description of the patellar surface. Here p. = *piano*, or level with surface of shaft at the upper anterior border at which estimates are formed. b.r. = *bas relievo*, m.r. = *mezzo relievo*, a.r. = *alto relievo*. These provide four rough categories as to elevation of patellar surface above shaft.]
HOMINIDAE	Homo sapiens	Recent Man	17th century Londoners ♂	·	85·22	104·43	70·84	90·06	33·05	49·99	88·83	71·0[illegible]	7·43	7·71	91·92	95·97	32·28	2·55	36·85	78·08	100·34	17·83	111·94	14·67	15·76	89·57	5·73	36·76	6·75	Head well above great trochanter. Lateral protrusion and 3rd trochanter only as anomalies; some protrusion of base of great trochanter. Anterior flattening above, on level of and slightly below 2nd trochanter; some posterior flattening in subtrochanteric region. No posterior fossa or *fossa angulolateralis* noticed even as anomalies, unless the latter can be linked up with hypotrochanteric fossa by some intermediate phase as possibly found in chimpanzee. Marked pilaster. Popliteal surface fairly well-defined, concave, but may be flat or convex, apex approximately determinable. Head well defined, mesial cut away of articular surface not infrequent as well as extensions of it as anomalies; fovea considerable and irregular in form. Patellar surface p. to b.r., short and without tongue.
„	„	„	„ „		82·87	101·61	67·92	90·57	32·84	50·86	88·61	70·75	[illegible]	7·30	92·12	95·98	31·99	2·50	41·13	79·91	100·80	17·25	110·78	14·48	15·29	88·53	5·62	36·74	6·61	
„	„	Primogenial Man	Neanderthal Type		77·6	108·1	79·4	107·6	35·4	45·8	82·4	70·3	[illegible]	8·4	87·2	105·5	31·9	3·7	53·5	82·8	110·7	20·8	98·6??	17·9	16·5	79·4	3·95	24·0	4·7	Head well above great trochanter, although less than in cases of orang or recent man. Anterior flattening above, posterior below 2nd trochanter. 3rd trochanter, lateral protrusion and hypotrochanteric fossa very usual, if not indeed universal. Crural trough frequently well-marked, and top of neck flat. Pilaster slight and popliteal area convex and less well defined than in recent man. Epiphyses relatively massive and marked bowing. Head well defined; casts and photographs do not indicate large extensions of articular surface. Large and irregular fovea. Patellar surface relatively short, more like that of greater anthropoids; it lacks the asymmetry of that of recent man, with its lateral peak; it is p. and without trace of tongue.
ANTHROPOIDEA	Simiinae	Simia	S. satyrus (Orang)	3 R + 2 L	71·7	82·1	65·9	97·[illegible]	27·7?	50·9	95·3	70·1	[illegible]	8·4	95·6	105·7	48·7?	1·8	45·2	66·7	81·2	21·2	82·7	15·3	19·8	93·3	8·3	42·0	10·7	Head well above great trochanter. Anterior flattening above, posterior below 2nd trochanter. No 3rd trochanter or posterior fossa; slight fossa angulolateralis. No pilaster or lateral protrusion. High collar angle and low pilastric index. Popliteal area convex, ill-defined and apex hardly appreciable. Head fairly well-defined, cut away mesially and less markedly on top of neck, scarcely any trace of a fovea. Patellar surface b.r., short and no trace of tongue.
„	„	Troglodytes	T. niger (Chimpanzee)	R + L	83·8	82·8	68·25	93·35	27·95?	40·55	95·7	75·25	10·05	8·3	102·35	109·55	47·85?	2·95	42·95	62·65	84·2	22·0	97·25	13·95	18·55	84·15	7·2	38·75	8·6	Head above great trochanter. Considerable anterior flattening above, slight posterior below 2nd trochanter. No 3rd trochanter or a slight ridge form surmounting well marked hypotrochanteric fossa. It is difficult to say whether this fossa in the chimpanzee does not to some extent correspond to the *fossa angulolateralis* of the gorilla, and to the trace of the latter in the orang. Lips of *linea aspera* more marked than in orang and so some traces of pilaster. Popliteal area convex and apex ill-defined. Head well defined, cut away top of neck, distinct fovea of human proportions. Patellar surface p., short and without trace of tongue.
„	„	„	T. gorilla ♂	3 R + 1 L	85·65	81·9	51·1	[illegible]	30·5?	59·1	103·65	70·1	[illegible]	10·1	101·3	89·4	48·55?	3·5	47·6	60·0	80·8	25·1	98·8	14·75	22·4	89·1	7·4	32·9	8·8	Great trochanter on same level or slightly above head. Anterior flattening above and relatively slight flattening below 2nd trochanter on both faces. There is often a marked ridge from base of 2nd trochanter forming mesial tip of *linea aspera*. Marked *fossa angulolateralis*; no lateral protrusion, no posterior fossa and little definite pilaster. Marked bowing. Popliteal surface varies, but at ⅔ diaphysial length may be described as flat to concave, it is better defined than in orang and guess may be made at apex as point of nearest approach of lips of *linea aspera*. Head well defined, fovea relatively small or may be almost absent, articular surface cut away mesially and on top of neck. Patellar surface p. to b.r., short and no sign of tongue.
„	„	„	„	3 R	83·9	80·8	51·[illegible]	80·3	34·3?	58·0	101·6	71·8	[illegible]	9·6	102·2	89·2	48·5?	3·2	48·5	61·6	83·2	23·9	96·1	14·9	21·9	91·7	7·1	32·4	8·6	
„	(Hylobatinae)	Hylobates	H. mülleri	2 R	83·7	108·15	78·2	100·0	·	43·95	81·35	78·95	[illegible]	5·4	95·2	91·5	?	−0·15	70·95	74·4	94·1	13·05	97·8	9·4	11·75	89·7	5·7	48·3	6·45	Head on same level or slightly above great trochanter. Some lateral protrusion and slight 3rd trochanteric ridge up base of great trochanter. Anterior flattening above and on level of 2nd trochanter, posterior from above to below 2nd trochanter. Lips of *linea aspera* very little marked, very little bowing, little attempt at a pilaster. No *fossa hypotrochanterica*, nor *fossa angulolateralis*, nor fossa of posterior face. Popliteal surface ill-defined, convex and apex very vague. Head well-defined if we exclude large cut-aways on top of neck and on mesial border, relatively large and irregular fovea. Patellar surface p. to b.r., of short length and without traces of tongue.
SIMIIDAE	Semnopithecinae	Semnopithecus	S. —?	R + L	111·[illegible]	100·0	65·5	110·5	?	62·0	93·0	59·9	[illegible]	6·4	119·7	115·2	?	1·4	37·0	71·7	101·5	16·2	109·5	11·8	13·4	95·2	6·2	39·9	7·0	[illegible]
„	„	„	S. frontalis	R + L	90·5	91·15	80·65	95·45	?	43·85	92·65	87·1	7	5·45	101·8	103·6	?	1·85	37·65	82·9	102·25	13·55	109·05	11·2	12·55	92·4	6·2	49·55	7·0	[illegible]
„	„	„	S. entellus (Hanuman Monkey)	R + L	[illegible]	105·45	75·95	115·35	23·35?	50·05	95·4	84·35	[illegible]	7·4	96·05	85·4	35·45?	4·3	43·2	85·0	102·0	14·85	83·55	12·3	12·85	86·6	6·8	53·1	7·9	[illegible]
„	„	„	Nasalis larvatus (Proboscis Monkey)	R + L	101·9	90·9	79·25	102·1	26·15?	57·95	102·9	77·1	[illegible]	7·15	102·2	106·05	36·4?	3·5	38·85	91·4	109·0	14·7	99·3	13·25	13·65	92·6	7·05	51·45	8·1	[illegible]
„	„	Colobus	Colobus satanas	R + L	84·9	103·45	85·4	108·8	21·75?	44·1	87·45	85·3	[illegible]	5·95	93·9	96·75	31·0?	3·5	38·05	86·4	107·25	13·8	75·7	12·0	13·0	94·0	7·45	57·45	8·5	[illegible]
„	Cynopithecinae	Cercopithecus	C. callitrichus	R + L	100·65	91·15	81·3	91·1	?	53·4	108·4	82·7	8	7·1	98·55	107·2	?	3·2	49·05	87·6	100·9	15·7	95·1	13·5	15·05	95·8	6·75	44·75	7·7	[illegible]
„	„	„	C. ?	R	90·8	104·2	85·3	93·5	?	53·2	102·1	88·1	8	8·2	91·0	93·0	?	4·2	39·8	90·2	98·4	15·0	103·2	13·5	13·9	92·7	6·5	46·8	7·2	[illegible]
„	„	„	C. lalandii	R + L	95·25	101·1	75·2	107·3	20·55?	55·6	100·05	79·8	[illegible]	7·45	94·3	93·2	44·95?	4·55	52·3	89·25	99·25	15·0	73·5	13·4	12·95	86·2	7·7	59·9	9·0	[illegible]
„	„	„	C. pousarquei	R	93·[illegible]	100·0	75·3	112·[illegible]	?	50·8	90·1	70·0	[illegible]	7·6	93·1	98·3	?	4·3	43·7	81·0	98·4	17·6	115·0	13·9	15·4	87·8	8·6	55·6	9·9	[illegible]
„	„	„	C. pousarquei†	L	90·1	100·0	80·1	100·4	?	?	100·0	85·3	7·7	7·7	98·3	94·0	?	4·0	44·2	?	?	?	?	?	?	?	?	?	9·0	[illegible]
„	„	(Cercocebus)	C. aterrimus	R + L	100·[illegible]	90·2	79·1	114·[illegible]	16·2?	40·3	91·3	89·9	9·7	6·7	107·6	88·6	46·1?	3·1	58·5	87·0	99·6	13·6	101·7	11·7	11·9	88·0	7·3	61·0	8·4	[illegible]
„	„	„	C. albigena	R + L	84·8	102·2	90·3	100·0	19·1?	53·4	92·4	80·5	6·8	6·9	89·8	102·2	41·0?	3·1	44·4	90·3	98·5	13·3	97·5	11·7	12·1	91·0	7·2	59·8	8·2	[illegible]
„	„	Macacus	M. nemestrinus	R + L	91·8	100·1	75·55	111·[illegible]	?	58·05	87·65	71·9	7	8·35	99·35	96·35	?	2·95	42·95	77·1	93·25	16·25	92·9	12·2	14·05	86·2	6·3	45·0	7·1	[illegible]
„	„	„	M. rhesus I	R + L	111·4	104·95	88·85	103·8	20·35?	40·65	102·1	81·8	[illegible]	7·7	103·95	103·6	33·9?	2·7	45·15	86·4	101·0	16·15	86·6	13·7	14·6	91·95	7·2	48·55	8·2	[illegible]
„	„	„	M. rhesus II	R + L	92·8	91·8	83·7	104·65	?	52·7	81·15	81·65	8·25	7·7	107·8	104·2	?	3·6	69·05	79·6	95·05	16·95	102·01	13·35	15·4	90·9	7·5	48·5	8·8	[illegible]
„	„	„	M. cynomolgus I	R + L	100·95	114·75	89·5	101·35	28·65?	50·2	96·6	79·45	[illegible]	9·1	96·45	98·25	31·15?	3·95	51·45	83·0	94·5	15·65	91·2	12·75	14·6	92·9	8·25	56·85	9·6	[illegible]
„	„	„	„ II	R + L	95·85	98·8	86·4	89·0	?	49·5	98·8	83·45	[illegible]	7·35	98·15	104·9	?	3·9	44·55	81·85	98·5	15·9	97·85	13·05	14·85	93·35	6·35	45·0	7·3	[illegible]
„	„	„	M. inuus (Barbary Ape)	R + L	85·85	100·4	73·95	112·15	?	53·5	98·55	79·05	8·45	8·45	86·8	93·2	?	3·4	34·35	83·95	100·6	17·3	103·15	14·5	15·7	90·9	7·0	44·4	8·3	[illegible]
„	„	„	M. speciosus† (Japanese Ape)	R	97·2	101·3	81·5	109·2	26·3?	52·6	104·9	87·3	9·7	9·8	91·5	92·2	42·2?	5·8	56·2	80·2	89·2	18·7	110·5	15·0	16·3	87·2	6·2	38·3	7·5	[illegible]
				L	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[7·0]	[54·3]	[illegible]	[illegible]	[18·2]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
„	„	Cynocephalus	Cynopithecus niger	R + L	88·15	101·35	79·8	96·55	?	52·05	89·7	81·85	7·85	7·85	97·15	96·25	?	4·15	48·85	86·5	98·75	15·95	101·7	13·5	14·35	90·0	5·9	41·0	[illegible]	[illegible]
„	„	„	Cynocephalus hamadryas	R + L	105·8	103·4	68·6	112·5	21·7	[illegible]	105·8	70·0	7·0	7·3	96·7	94·7	46·4?	3·4	41·2	84·1	91·5	14·3	100·0	11·6	13·6	95·4	5·8	42·4	[illegible]	[illegible]
„	„	„	Cynocephalus porcarius (Chacma)	R + L	89·35	91·35	79·0	88·0	?	55·15	97·05	77·7	7·85	7·5	97·6	107·8	?	4·2	46·6	81·4	94·75	16·5	85·2	13·2	15·95	96·1	6·7	42·1	7·6	[illegible]
„	„	„	Papio maimon	R + L	96·3	105·65	80·5	105·5	23·6	51·5	96·55	85·85	8·55	9·0	94·4	88·75	42·1?	2·9	54·0	87·3	103·8	17·0	88·3	14·7	15·55	91·35	8·6	55·0	[illegible]	[illegible]
CEBIDAE	Cebinae	Ateles	A. ater	R + L	96·6	91·0	65·2	102·8	17·1?	40·0	92·4	81·[illegible]	7·0	9·4	114·8	87·7	50·4?	3·0	42·7	70·7	98·75	15·6	80·0	11·1	13·9	89·6	6·0	35·7	5·7	[illegible]
„	„	„	A. panniscus	R + L	92·05	98·65	67·75	106·65	25·15?	65·9	88·65	[illegible]	7·35	7·25	105·25	101·05	43·05?	1·55	57·95	75·8	92·25	13·95	110·85	11·0	13·4	96·15	5·5	41·3	6·5	[illegible]
„	„	Eriodes	No skeleton available																											
„	„	Lagothrix	L. Humboldtii	R + L	94·35	107·75	66·55	99·4	?	50·35	80·35	62·5	8·1	8·7	109·05	98·8	?	1·7	48·65	59·55	97·4	19·65	105·4	11·9	17·8	90·7	5·7	32·05	6·8	[illegible]
„	„	Cebus	C. flavius	R + L	89·0	97·8	72·3	102·5	?	43·6	88·45	[illegible]	6·25	6·15	103·05	91·7	?	1·55	45·7	75·3	96·95	15·9	113·2	12·0	13·6	85·3	6·2	45·55	7·1	[illegible]
„	„	„	C. —?	R + L	87·0	85·4	67·7	94·65	?	48·1	88·35	78·4	6·85	5·85	115·45	100·9	?	1·1	37·3?	68·6	97·5	15·7	102·8	10·8	14·5	92·4	5·5	38·1	6·4	[illegible]
„	„	„	C. capuchinus	R + L	84·35	91·65	68·9	105·95	?	47·25	85·45	79·6	6·8	6·25	107·65	94·4	?	1·7	63·95	70·85	95·45	15·95	100·0	11·3	14·2	89·4	6·35	44·5	7·3	[illegible]
„	Mycetinae	Mycetes	M. palliatus	R + L	92·75	94·25	74·35	90·3		43·2	98·0	85·1	7·1	6·7	100·55	92·7	?	3·0	41·3	72·95	96·65	16·9	102·7	12·6	15·1	89·1	6·25	47·45	7·3	[illegible]
„	Pitheciinae	Pithecia	P. monarchia (Saki Monkey)	R + L	88·2	97·8	74·1	99·1	?	44·65	88·25	80·4	5·75	5·6	102·25	84·75	?	1·25	40·55	77·95	101·55	12·95	101·7	10·25	11·75	90·75	5·15	43·95	5·8	[illegible]
„	„	Brachyurus	B. rubicundus (Redfaced Ouakari)	R + L	88·5	103·5	67·25	100·8	?	47·45	81·6	[illegible]	5·1	5·25	104·75	86·45	?	1·95	47·75	78·4	103·65	12·8	108·9	10·15	11·3	87·9	6·3	55·7	7·1	[illegible]
„	Nyctipithecinae	Nyctipithecus	N. lemurinus	R + L	94·5	97·5	82·2	108·4	?	42·95	85·75	[illegible]	5·7	5·55	113·15	109·2	?	2·15	49·3	81·3	98·5	15·4	86·5?	12·6	11·95	77·45	6·8	57·1	7·9	[illegible]
„	„	Chrysothrix	C. sciurea I	R + L	73·95	94·6	62·65	115·4	?	46·75	80·85	[illegible]	6·0	5·7	96·7	81·75	?	0·0	—	84·0	101·9	14·1	117·1	12·0	12·55	89·45	5·75	45·9	6·5	[illegible]
„	„	„	„ II	R + L	86·1	95·0	66·9	108·8	?	52·7	89·3	[illegible]	6·05	5·75	102·15	95·75	?	0·35	40·05	83·35	97·7	14·1	110·1	11·8	13·3	94·6	6·2	46·75	7·0	[illegible]
„	„	Callithrix	C. personatus	R + L	87·3	92·4	68·9	107·95	?	54·15	83·4	[illegible]	5·85	5·5	113·45	116·5	?	1·1	49·7	88·1	106·35	15·2	102·65	13·65	14·1	92·75	6·45	45·9	7·4	[illegible]
„	Hapalinae	Hapale	Hapale Jacchus	R + L	80·2	97·1	67·8	98·45	?	54·7	81·35	74·25	6·7	6·5	101·45	94·0	?	3·15	54·05	82·35	112·0	14·95	98·2	12·35	14·55	94·05	6·9	47·9	8·0	[illegible]
„	„	„	Jacchus —? I	R + L	100·0	97·0	72·45	104·8	?	55·4	100·0	75·85	6·6	6·4	103·15	98·45	?	2·9	49·4	93·0	109·85	14·3	108·2	13·15	12·95	90·45	8·1	62·7	9·2	[illegible]
„	„	„	Jacchus —? II	R + L	82·5	108·2	72·25	106·05	?	47·35	79·0	75·0	5·75	6·25	96·85	89·3	?	0·8	46·25	83·55	97·6	14·45	107·5	12·25	12·0	82·3	7·45	62·0	8·8	[illegible]
„	„	„	Jacchus auritus	R + L	82·45	89·8	82·4	93·3	?	43·6	92·0	85	6·8	6·1	100·0	107·15	?	2·35	54·15	83·35	107·5	16·3	85·3	13·65	14·95	91·95	6·7	44·8	[illegible]	[illegible]
„	„	Midas	M. midas	R + L	92·15	94·05	80·0	113·55	?	47·45	93·05	[illegible]	7·5	7·1	104·55	100·0	?	2·45	49·75	85·35	100·45	16·8	83·4	14·3	14·3	84·9	7·4	51·8	[illegible]	[illegible]
„	„	„	M. auritus	R + L	93·55	86·65	78·2	101·25	?	48·25	89·0	88·2	8·05	6·95	121·55	102·35	?	2·75	52·4	78·1	101·7	16·65	84·9	12·9	14·95	89·95	6·85	46·0	[illegible]	[illegible]
„	„	„	M. ursulus I (Negro tamarin)	R + L	105·05	92·65	80·05	108·4		47·6	103·8	91·25	7·3	6·8	109·25	94·75	?	2·3	60·2	92·6	108·05	14·85	85·0	13·6	14·15	95·25	7·4	52·2	[illegible]	[illegible]
„	„	„	M. ursulus II „ „	R + L	93·55	95·1	75·55	106·75	?	52·1	105·3	[illegible]	6·75	6·4	93·75	96·25	?	2·2	44·45	90·45	102·4	14·1	80·0	12·85	11·7	82·95	6·6	56·5	[illegible]	[illegible]
LEMUROIDEA	Lemuridae	Indrisinae	Propithecus diadema	R + L	76·4	113·6	80·4	108·5	?	49·0	80·0	85·1	5·1	5·8	84·0	89·0	?	0·8	66·2	109·0	114·5	11·2	104·0	12·0	10·4	92·4	5·7	55·2	[illegible]	[illegible]
„	„	„	„ deckeni	R + L	85·7	105·5	84·0	111·2	?	49·5	86·7	85·8	5·5	5·9	93·8	92·7	?	0·0	—	106·1	110·7	11·8	119·4	12·3	11·3	95·8	6·6	58·5	[illegible]	[illegible]
„	„	„	„ coronatus	R + L	95·45	85·15	78·35	108·95	?	53·05	97·0	80·5	6·65	5·65	115·6	102·8	?	0·85	66·25	107·9	115·5	12·85	108·7	13·55	11·75	91·1	8·65	73·6	[illegible]	[illegible]
„	„	„	Avahis laniger	R + L	93·8	102·6	77·7	98·1	?	45·95	92·3	92·35	4·9	5·0	99·25	82·15	?	0·75	64·45	118·05	105·0	10·6	103·85	12·4	10·3	93·6	6·15	61·9	[illegible]	[illegible]
„	„	Lemurinae	L. rubiventer I	L	97·3	85·4	84·5	101·4	?	52·2	110·8	[illegible]	7·0	6·3	102·9	101·4	?	1·2	59·8	105·0	109·7	12·6	124·6	13·1	11·6	91·9	9·8	84·5	[illegible]	[illegible]
„	„	„	„ II	L	97·5	114·3	86·4	101·3	?	50·3	87·5	79·5	6·1	6·9	97·5	94·0	?	−1·3	34·9	97·1	103·0	14·0	104·5	13·2	12·6	90·3	9·1	72·2	[illegible]	[illegible]
„	„	„	L. macaco	R + L	102·8	108·7	89·8	99·0	?	45·6	86·0	85·2	6·8	7·4	110·0	97·0	?	−1·8	29·6	97·0	112·7	15·8	106·7	15·1	13·3	84·4	10·2	76·5	[illegible]	[illegible]
„	„	„	L. niger	R + L	[illegible]	89·0	77·5	101·4		52·2	83·7	88·2	6·7	6·0	106·8	100·0	?	0·8	70·2	109·0	112·1	13·3	100·0	14·1	12·1	91·0	11·0	91·4	[illegible]	[illegible]
„	„	„	L. catta	R + L	92·8	100·0	85·7	114·9	?	45·0	87·0	[illegible]	6·3	6·3	106·7	96·0	?	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
„	„	„	L. melanocephalus (Mongoz)	R + L	91·1	91·8	87·25	101·8	?	48·8	90·55	96·15	7·2	6·85	106·1	95·75	?	0·5	36·05	101·35	103·85	14·0	98·6	14·05	12·25	87·55	10·4	84·85	[illegible]	[illegible]
„	„	„	L. macaco niger	R + L	95·35	100·0	84·15	105·3	?	51·9	82·9	79·2	6·6	7·05	107·65	99·45	?	−0·0	?	96·9	97·7	14·5	85·5	13·7	13·8	95·35	10·05	72·95	[illegible]	[illegible]
„	„	„	L. macaco leucomystax	R + L	80·2	92·7	82·4	117·3	?	52·0	85·4	90·1	6·6	6·1	101·3	98·7	?	0·0	?	109·1	107·9	13·0	83·6	13·8	11·1	85·7	8·7	78·0	[illegible]	[illegible]
„	„	„	L. rufifrons	R + L	87·4	91·3	79·45	110·0	?	50·35	87·4	96·05	6·65	6·6	100·7	83·35	?	0·0	?	107·7	104·5	12·6	87·7	13·2	12·05	90·35	8·45	69·0	[illegible]	[illegible]
„	„	„	Hapalemur griseus	R + L	81·1	110·0	90·15	97·05	?	48·8	69·0	78·55	5·0	5·5	106·8	111·35	?	−1·8	40·0	111·0	105·95	12·15	77·75	13·05	10·9	89·95	7·95	72·9	[illegible]	[illegible]
„	„	Galaginae	Galago crassicaudatus	R + L	100·0	102·7	89·05	101·7	?	54·3	100·0	81·8	7·85	8·1	97·4	106·1	?	−2·2	29·75	115·45	100·0	15·65	68·9	18·25	14·25	90·9	11·85	82·95	[illegible]	[illegible]
„	„	„	„ alleni	R + L	91·05	122·0	98·8	103·75	?	50·05	78·65	86·45	5·1	6·3	94·15	93·0	?	−1·55	38·95	107·55	101·8	10·85	85·9	11·85	10·4	95·65	6·25	60·1	[illegible]	[illegible]
„	„	„	Chirogaleus	R + L	131·55	108·2	73·65	105·45	?	51·1	105·0	69·9	6·7	7·15	115·0	97·5	?	−0·3?	64·6?	89·8?	108·65	16·55	70·65	14·65	13·85	83·7	9·05	65·25	[illegible]	[illegible]
„	„	Lorisinae	Loris gracilis	R + L	89·35	85·15	55·8	117·7	?	59·45	98·7	71·2	6·25	5·3	106·4	92·05	?	−2·35	42·05	72·6	92·0	13·1	86·25?	9·55	10·0	76·55	5·4	53·7	[illegible]	[illegible]
„	„	„	Nycticebus javanicus	R + L	96·15	88·4	62·15	105·0	?	55·55	100·15	73·55	7·5	6·6	108·8	95·65	?	−2·45	23·45	63·45	79·5	16·35	62·0	10·65	13·5	82·55	8·35	61·55	[illegible]	[illegible]
„	„	„	Potto	R + L	88·2	94·9	59·85	112·5	?	57·35	99·2	70·05	7·85	7·4	93·7	90·1	?	−2·3	27·25	70·1	89·1	16·85	97·45	12·05	13·95	82·85	7·9	56·45	[illegible]	[illegible]
„	Chiromyidae	Chiromys	Chiromys (Aye-Aye)	R + L	82·95	97·3	76·85	95·8	?	47·6	87·1	83·6	6·5	6·4	96·6	94·4	?	1·15	39·9	88·7	107·9	14·95	77·45	13·35	12·85	86·05	5·45	49·7	[illegible]	[illegible]
„	Tarsiidae	Tarsius	Tarsius spectrum	R + L	88·85	115·7	106·6	121·15	?	44·2	83·3	95·05	1·85	5·6	89·9	94·2	?	−1·25	29·7	119·6?	99·4	10·75	70·9	12·9	9·5	88·45	9·2	96·75	[illegible]	[illegible]
	Pliocene Fossils	Simopithecus	S. oswaldi		104·0	112·5	84·2	104·8	—	—	91·4	79·2	10·1?	11·3?	101·1	94·4	—	4·1	40·0	—	—	—	—	—	—	—	—	—	—	[illegible]
	„	Dryopithecus	D. rhenanus (Eppelsheimer femur)	L	91·5	98·3	63·5	80·0	?	61·3	87·1	69·4	6·9	7·0	103·3	89·9	?	0·6	29·4	75·4	103·3	14·3	94·9	10·9	12·3	85·9	6·6	47·6	[illegible]	[illegible]

† Left member pathological

[illegible] Apes and Lem

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